

# Identifying and managing adverse environmental health effects:

## 1. Taking an exposure history

Lynn Marshall,\* Erica Weir,<sup>†</sup> Alan Abelsohn,<sup>‡</sup>  
Margaret D. Sanborn<sup>§</sup>

### Abstract

PUBLIC CONCERN AND AWARENESS ARE GROWING about adverse health effects of exposure to environmental contaminants. Frequently patients present to their physicians with questions or concerns about exposures to such substances as lead, air pollutants and pesticides. Most primary care physicians lack training in and knowledge of the clinical recognition, management and avoidance of such exposures. We have found that it can be helpful to use the CH<sup>2</sup>OPD<sup>2</sup> mnemonic (Community, Home, Hobbies, Occupation, Personal habits, Diet and Drugs) as a tool to identify a patient's history of exposures to potentially toxic environmental contaminants. In this article we discuss why it is important to take a patient's environmental exposure history, when and how to take the history, and how to interpret the findings. Possible routes of exposure and common sources of potentially toxic biological, physical and chemical substances are identified. A case of sick-building syndrome is used to illustrate the use of the mnemonic.

### Case

A 40-year-old married bookkeeper presents with a 3-year history of headaches. She describes having "tight," bitemporal headaches almost daily that resolve after taking three 325-mg tablets of ASA. She also complains of a "spacey" feeling, difficulty concentrating and remembering, fatigue, a stuffy nose and a full feeling in her ears. Her symptoms improve on weekends and over the holidays and seem to be worse in the winter. Over the past 2 years she has noticed that she gets a stuffy nose and headaches when exposed to perfumes, tobacco smoke and automobile exhaust. Her past medical history is remarkable only for infantile eczema. Her family history is unremarkable other than her mother having hypothyroidism. She is taking no medications other than ASA, does not smoke, reports having no allergies and says she is happily married with no major family, financial or social concerns. She enjoys her work and coworkers. On physical examination she has puffy, dark circles under her eyes, there is loss of light reflex on her left ear drum, and her nasal mucosa appears edematous and erythematous. There are multiple excoriated, erythematous papules 5 mm in diameter on her face, anterior chest and anterior lower legs.

Questions surrounding this case: What is sick-building syndrome and how do patients commonly present? What causes or contributes to sick-building syndrome? What are the risk factors? How should cases be managed?

### Why is taking an environmental exposure history important?

Health Canada recently issued a warning to parents about the unacceptable health risks from exposure to diisononyl phthalate in children under 1 year old

*Review*

*Synthèse*

From \*the Environmental Health Clinic, Sunnybrook & Women's College Health Sciences Centre, Toronto, Ont.; †the Community Medicine Residency Program, Department of Clinical Epidemiology and Biostatistics, and §the Department of Family Medicine, McMaster University, Hamilton, Ont.; and ‡the Department of Family and Community Medicine, University of Toronto, Toronto, Ont.

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who chew on toys made of polyvinyl chloride for extended periods.<sup>1</sup> When warnings such as these are issued parents seek advice and answers from physicians to such questions as: What is diisononyl phthalate? Are there other sources besides plastic toys? Could something in the environment be causing me to feel this crummy? In a recent survey Ontario family physicians reported that they are asked many questions by patients about the environment, yet most of the physicians rated their level of knowledge on environmental health issues to be very low.<sup>2</sup>

The task of identifying, measuring and reducing the risks to human health associated with environmental exposure to toxins can be difficult, its accomplishment hindered by the scale of the problem and by the limits of data and methodology. Research bodies such as the International Joint Commission and Health Canada's Great Lakes Health Effects Program may invoke the "precautionary principle" when weighing the accumulated evidence from wildlife studies, toxicological research on laboratory animals, epidemiological data and case reports of accidental poisonings. In 1997 Health Canada issued a statement saying that "the weight of evidence indicates that certain heavy metals and persistent chlorinated contaminants, present as low level contaminants in the Great Lakes basin, can cause adverse health effects in animals and humans."<sup>3</sup> These effects can be acute and chronic. The International Joint Commission compiled a list of 11 critical pollutants: PCBs, dioxins, furans, toxaphene, DDT, mirex, dieldrin, hexachlorobenzene and benzopyrene, methyl mercury and alkyl lead.<sup>4</sup> All humans have body burdens of foreign chemicals. These "xenobiotics" enter the body through inhalation, ingestion and skin contact and can be found throughout the body, including serum,<sup>5</sup> breast milk,<sup>6</sup> semen,<sup>7</sup> adipose tissue,<sup>8</sup> bone<sup>9</sup> and follicular fluid.<sup>10</sup>

Environmental health problems frequently present as common medical problems (e.g., headache, difficulty concentrating, behavioural problems, rashes, asthma, angina, myalgia, difficulty conceiving, spontaneous abortions).<sup>11,12</sup> However, consideration of environmental factors rarely enters into the clinician's history taking or diagnosis. A chart review of 2922 histories taken by 137 third-year medical students showed that smoking status was documented in 91% of cases, occupation in 70% and specific occupational exposures in 8.4%. Patients less than 40 years of age and women were significantly less likely than older patients or men to have their occupation and industry noted.<sup>13</sup> Since patterns of history taking and differential diagnoses are set in medical school, it appears that physicians and their educators are lagging behind public concern and awareness about environmental exposures.<sup>14</sup> However, with more than 70 000 industrial chemicals in use,<sup>11</sup> it is simply not possible for a physician to sit down and run through a checklist of possible exposures with everyone. An organized approach and framework is therefore essential.

## When should the history be taken?

It may be fruitful to take an environmental exposure history at a patient's entry into the practice; when a patient has a family history of asthma, allergies or autoimmune disease; during prenatal or preconception counselling; when a patient links onset of symptoms to environmental exposures; when a patient reports puzzling, nonspecific symptoms; or when a patient or family presents with frequent office visits for various illnesses.

In the sample case described earlier, a previously healthy patient presents with a 3-year history of various puzzling, nonspecific symptoms.

## How should the history be taken?

The task of identifying a particular exposure that might be related to an array of symptoms can be like looking for a needle in a haystack. An efficient approach involves searching for a change in the environment related to symptom onset or exacerbation rather than looking for a specific exposure. Since the timing of symptom onset or exacerbation is often linked to the source or setting of the exposure, it helps to organize the exposure history by the possible source or setting using the CH<sup>2</sup>OPD<sup>2</sup> mnemonic (Community, Home, Hobbies, Occupation, Personal habits, Diet and Drugs) to direct general questions (Table 1).

More specific questions can be asked about whether the symptoms are temporally related to being in the home, work or community environments and whether the onset

**Table 1: The CH<sup>2</sup>OPD<sup>2</sup> mnemonic for taking an environmental exposure history**

Code	Category	Question
C	Community	Do you live near a hazardous waste site or any industrial facilities that give off chemical odours?
H	Home	Is your home more than 40 years old? Have you done renovations? Do you use pesticides in your home or on your garden or pets?
H	Hobbies	Do you work with stained glass or oil-based paints or varnishes?
O	Occupation	Describe your workplace air quality and what you do
P	Personal habits	Do you or family members smoke? What sort of personal care products do you use?
D	Diet	What is your source of drinking water? How often do you eat tuna or sportfish?
D	Drugs	Besides what I have prescribed, are you taking any over-the-counter or home remedies?

was associated with any recent dietary or environmental changes such as a move, a new work location, renovations, new hobbies, furniture, plants or pets. Are symptoms better on weekends? Are they present when away from home or on vacation? Do they occur in other specific settings? Does anyone else at home or at work have these or other symptoms that started around the same time?

An exposure history questionnaire organized according to the CH<sup>2</sup>OPD<sup>2</sup> mnemonic is available at [www.cfpc.ca/ocfp/index.html](http://www.cfpc.ca/ocfp/index.html) (click on "Exposure History Sheets in MS Word" in the scrolling menu located in the middle of the Web page). The environmental exposure history of the patient in the sample case is summarized in Table 2.

## Interpreting the findings

The environmental exposure history of the patient in the sample case suggests that symptom onset was related to her occupational history, indicating a possible toxic occupational exposure. It is helpful to think in terms of major pathways of exposure using a simple schema, adopted by Health Canada's Great Lakes Health Effects Program.<sup>15</sup> This schema links the type of exposure (biological, physical or chemical) to the environmental media (air, soil, food or water) and the routes of exposure (inhalation, skin contact or ingestion). It is helpful to think of soil in the broad terms of surface contacts (e.g., plastic toys) rather than simply soil (e.g.,

playground dirt as a potential source of residual lead). Tables 3 to 6 identify common examples of biological, physical and chemical contaminants that individuals may encounter.

## Linking the symptoms to the exposure

A possible link between the exposure and the symptoms is established on the basis of observation and correlation. When exposure to potential hazards associated with either the onset or worsening of symptoms is identified by the environmental exposure history, the physician can either advise precautionary avoidance or refer to an environmental, occupational or public health specialist for further assistance with management. Certified industrial hygienists, environmental engineers or home inspectors certified by Canada Mortgage and Housing Corporation can investigate exposures using more detailed measurement tools.

Given the exposure history in the sample case (Table 2), it seems likely that the woman's symptoms are linked to an occupational environmental exposure, in a poorly ventilated office, to volatile organic compounds in the photocopier ink or to ozone produced secondary to the

**Table 2: Environmental exposure history of sample case**

Category	History
Community	The patient has lived in the same small village for 12 years. As far as she knows there are no major polluters or industrial sites nearby.
Home	The patient has lived in the same house for 12 years. She had the oil heater replaced with electric heating 5 years ago; there have been no recent renovations. She is an avid organic gardener and has had a large number of indoor plants for 10 years or more. There has been a cat in the house for 10 years.
Hobbies	The patient has knitted for 20 years and sings in a choir.
Occupation	Three years ago the patient started to work in a building supply store. She works alone in a small office with a small window (sealed in winter). There is an unvented photocopier in her office, which is used frequently throughout the workday.
Personal habits	The patient is happily married with no major family, financial or social problems. She enjoys her work and her coworkers. She and her husband are nonsmokers. She occasionally drinks alcohol socially, although for about the past year she has noted that she can tolerate much less alcohol than she could previously. For the past 2 years she has avoided using scented products at home.
Diet	The patient generally follows Canada's Food Guide to Healthy Eating.
Drugs	She uses no medications except for ASA for headaches and a daily multiple vitamin and mineral supplement that she has been taking for the past 2 years.

**Table 3: Examples and potential sources of biological environmental exposures<sup>12,16,17</sup>**

Examples	Potential sources
Moulds, fungi	Roof or pipe leaks, condensation on windows or outside walls, cluttered basements, large numbers of indoor plants
Bacteria	Food, water, air, poorly maintained ventilation systems, infected animals
Viruses	Infected person (airborne transmission), enclosed spaces
Dust mites	Bedding, carpeting, furniture, rooms with high humidity (> 50%)
Pet dander, saliva, feathers	Cats, dogs, birds
Pollen	Trees, grasses, weeds (seasonal)

**Table 4: Examples and potential sources of physical environmental exposures<sup>12,16,17</sup>**

Example	Potential sources
Heat	Industrial processes, variations in office temperature
Cold	Outdoor winter work
Noise	Industrial processes, loud music
Ionizing radiation	Radon gas entering through cracked foundations, nuclear power plants, x-rays, radiotherapy
Nonionizing radiation	Excessive sunlight exposure (melanoma, snow blindness); reduced sunlight exposure (seasonal affective disorder)
Electromagnetic radiation	Electrical equipment (e.g., banks of computers, high tension power lines)

photocopying process.<sup>18</sup> The physician adopted a precautionary approach by advising the woman to avoid exposure to the photocopier. After it was removed from her office and the window opened, the patient's symptoms cleared and did not return.

## The questions answered

### *What is sick-building syndrome and how do patients commonly present?*

In the 1970s there were reports of symptoms linked with occupancy of buildings that had been deliberately "tightened" to conserve energy during a Middle East oil embargo. In 1982 and 1984 the World Health Organization described "symptoms with increased frequency in buildings with indoor climate problems."<sup>19,20</sup> These nonspecific symptoms included irritation of the eyes, nose and throat, dry, red mucous membranes and skin, headache, upper respiratory tract infections, lower airway symptoms, abnormal taste, distorted sense of smell, general fatigue, dizziness and

nausea. These symptoms are associated with being in a particular building by the temporal pattern of their occurrence and the clustering among inhabitants or colleagues, and by the absence of a specific illness such as hypersensitivity pneumonitis or infection.<sup>21</sup>

### *What causes or contributes to sick-building syndrome?*

Investigations into sick-building syndrome have suggested that its origins are multifactorial,<sup>22,23</sup> and several pathophysiological mechanisms have been hypothesized.<sup>24-26</sup> Four predominant factors appear to contribute to the syndrome: air contaminants, poor ventilation, host factors and work organization factors (e.g., job satisfaction, stress and social structures).<sup>21,22</sup>

### *What are the risk factors?*

Risk factors for sick-building syndrome include atopy, female sex, low-paying, low-status job category, handling of

**Table 5: Examples and potential sources of chemical (metals, fibres, inorganic compounds) exposures in the environment<sup>12,16,17</sup>**

Example	Potential sources
<b>Metals*</b>	
Aluminum	Drinking water, antacids, antiperspirants
Cadmium	Tobacco smoke, electroplating, batteries, shellfish, plant foods grown in soil exposed to repeated years of phosphate fertilizer
Chromium, copper, arsenic	Pressure-treated lumber
Lead	Old flaking paint or lead pipes (house built before 1950), lead solder in water pipes (plumbing installed before 1989), renovation work, lead smelter, pottery or stained glass hobby, contaminated soil near site of heavy traffic before 1990, imported folk medicines
Mercury	Broken thermometers, discarded sphygmomanometers, dilation and feeding tubes, fluorescent bulbs, dental amalgam (inorganic compound), heavy fish consumption (organic compound [methyl mercury])
<b>Fibres</b>	
Asbestos	Crumbling pipe or boiler insulation, old vinyl linoleum, old ceiling tiles
Fibreglass	Insulation
<b>Inorganic compounds</b>	
Fluorides	High water fluoridation, some pharmaceuticals, some industries
Nitrates, nitrites	Fertilizers, food preservatives
Nitrogen dioxide, sulfur dioxide	Motor vehicle exhaust, industrial emissions, gas stoves, fireplaces
Ozone	Photochemical reaction with nitrogen dioxide and sulfur dioxide, electrostatic precipitators, photocopiers
Phosphates	Fertilizers, detergents, sewage treatment effluent
Silicon dioxide	Mining, sandblasting, abrasive processing
Sodium hypochlorite	Household bleach
Sulfites	Food and medication preservatives

\*May combine with other elements to form inorganic or organic compounds.

**Table 6: Examples and potential sources of nonbiological organic chemicals\* in the environment<sup>12,16,17</sup>**

Example	Potential sources	Example	Potential sources
<b>Adhesives</b>		<b>Gasoline</b>	
Butadiene, diisocyanates, formaldehyde, styrene, toluene	Epoxy resin glues, carpet backing	Benzene, ethylene dibromide, hexanes, toluene, trimethylpentane, xylene	Fuel for motorized vehicles
<b>Alcohols</b>		<b>Ink</b>	
Ethyl alcohol	Alcoholic beverages, solvents, diluent for gasoline, disinfectants	Benzene, formaldehyde, phenol	Computer printers, copiers, newsprint, magazines
Ethylene glycol	Solvents, antifreeze	<b>Paint</b>	
Glycerol	Perfumes, cosmetics, medicines (including suppositories)	Benzene, diisocyanates, toluene, trichloroethane, trichloroethylene, xylene	Oil-based paints and varnishes
Isopropyl alcohol	Solvents, disinfectants	<b>Paint remover</b>	
Methyl alcohol	Solvents	Methylene chloride (metabolizes in liver to carbon monoxide)	Paint solvents
Menthol	Perfumes, cosmetics, cough candies	<b>Paper/textiles</b>	
<b>Carpet</b>		Chlorinated compounds, formaldehyde	Bleached paper products, finish on textiles
Butylated hydroxy toluene	Polyurethane backing	<b>Perfume</b>	
2-Ethyl-1-hexanol	Polyvinyl chloride (PVC) backing	Acetone, benzaldehyde, ethanol, limonene	Toiletries, cosmetics, scents
Formaldehyde	PVC backing	<b>Persistent organic pollutants</b>	
Isooctane	PVC backing	Dioxins, furans, polychlorinated biphenyls (PCBs), organochlorines	Incineration, industry, pesticides
4-Phenylcyclohexane	"New carpet" odour, styrene-butadiene rubber latex backing	<b>Pesticides†</b>	
Propanediol	PVC backing	Acrylonitrile, aluminum phosphide, carbon disulphide, chloropicrin, DBCP, ethylene dibromide, ethylene oxide, formaldehyde, methylbromide	Fumigants
Styrene	Styrene-butadiene rubber latex backing	Captan, copper sulphate, folpet	Fungicides
Vinyl acetate	PVC backing	Alachlor, atrazine, diquat, glyphosate, MCPA, metolachlor, paraquat, 2,4-D, 2,4,5-T	Herbicides
<b>Combustion products</b>		Aldrin, carbaryl, chlordane, chlorpyrifos, DDT, DEET, diazinon, dieldrin, heptachlor, kepone, leptophos, lindane, malathion, methomyl, mirex, parathion, propoxur, pyrethrins, rotenone	Insecticides
Carbon dioxide, carbon monoxide, tars, etc.	Tobacco smoke, vehicle exhaust, furnaces, gas stoves, woodstoves, poor indoor ventilation, congested cities	ANTU, diphacinone, fluoroacetamide, PNU, sodium fluoroacetate, Vacor, warfarin, zinc phosphide	Rodenticides
<b>Cleaning/laundry products</b>		<b>Plant dusts/fumes</b>	
Ammonia, enzymes, formaldehyde, perfumes, phenol, phosphates	Window, floor and wall cleansers, laundry whiteners and detergents	Antigenic plant proteins	Flour (baker's)
<b>Dry-cleaning chemicals</b>		Terpenes	Florists, multiple house plants
Ethylene dichloride	Dry cleaners, unventilated dry-cleaned clothes	<b>Plastics</b>	
Tetrachlorethylene	Dry cleaners, unventilated dry-cleaned clothes, shoe polishes	Formaldehyde, phenol, phthalic acid esters, trimetallic anhydride, vinyl chloride	Toys, food containers, intravenous and respiratory tubing, blood storage bags
Trichlorethylene	Leathers, dry cleaners, unventilated dry-cleaned clothes	<b>Wood preservatives</b>	
Trichloroethane	Dry cleaners, unventilated dry-cleaned clothes	Formaldehyde	Particle board
<b>Drugs</b>		Pentachlorophenol	Lumber
Prescription	CPS, amphetamines, benzodiazepines, opioids		
Nonprescription "Recreational"	Over-the-counter drugs, folk remedies		
<b>Food colours</b>			
Erythrosine (red 3- and xanthine-related)	Meats, beverages, confections		
Tartrazine (FD&C #5)	Beverages, confections		
<b>Food and drug preservatives</b>			
Butylated hydroxy anisole, butylated hydroxy toluene	Potato chips		
Formaldehyde	Grain, fruit and vegetable fumigants		
Nitrosamines	Formed from nitrites in bacon, ham		

Note: CPS = *Compendium of Pharmaceuticals and Specialties*, DBCP = 1,2-dibromo-3-chloropropane, MCPA = 2-methyl-4-chlorophenoxyacetic acid, 2,4-D = 2,4-dichlorophenoxyacetic acid, 2,4,5-T = 2,4,5-trichlorophenoxyacetic acid, DDT = dichlorodiphenyltrichloroethane, DEET = N,N-diethyl-meta-toluamide, ANTU =  $\alpha$ -naphthylthiourea, PNU = N-3-pyridylmethyl-N'-p-nitrophenyl urea.

\*Organic compounds contain carbon.

†Found in air (e.g., sprays, flea collars, powders), food, soil and water.

paper, a job in a workplace with poor mechanical ventilation and inadequately maintained air conditioning, use of a video-display terminal, outdoor-air flow rates below 10 L/s per person, airway hyperreactivity and existing respiratory or dermatological disease.<sup>21,22</sup>

Employees exposed to toxic chemical spills at work have subsequently reported symptoms on exposure to apparently chemically unrelated, commonly encountered environmental contaminants at low levels.<sup>27</sup> The patient in the sample case noted that the occurrence of her symptoms had spread to occasions when she was exposed to chemicals outside the workplace (perfumes, tobacco smoke, automobile exhaust).

### How should cases be managed?

First take an environmental exposure history using the CHOPD<sup>2</sup> mnemonic and then a more extensive history if a site-specific exposure is suspected. Suggest that the patient avoid exposure; for example, in the sample case the volatile emissions from the photocopier (ink, ozone) can be avoided by having the photocopier removed from the office and improving ventilation by opening the office window. Get the patient's signed consent to allow you to make this recommendation to the employer (supervisor or human resources director) directly, either by telephone or letter. Ask the patient to request the Material Safety Data Sheets (MSDS [www.hc-sc.gc.ca/ehp/ehd/psb/whmis/msds.htm]) for materials used in relevant areas of the workplace. These sheets must be made available to the employer by the suppliers of all hazardous products used in the workplace and, in turn, must be readily available to employees. The sheets outline known adverse health effects related to exposure to the materials and recommend precautions. If the employer seems unwilling to accommodate the worker, contact the employer again and use the information in the MSDS to reinforce your recommendation.<sup>28,29</sup> The Occupational Health and Safety Act of Ontario<sup>30</sup> states that, in general, any workplace in the province that regularly employs 20 or more people must have a joint health and safety committee composed of members who represent the employer and the employees. It is the role of this committee to identify potential health and safety problems and to bring them to the attention of the employer. If the patient is a member of a union, union representatives may be helpful in advocating for the patient. If necessary, the employee can refuse to work in the unremediated environment, and the Ministry of Labour will be compelled to investigate. If the patient's symptoms do not improve after the workplace environment has been modified, then referral to an environmental or occupational health specialist is indicated.

[A detailed exposure history questionnaire is available on the Ontario College of Family Physicians Web site (www.cfpc.ca/ocfp/index.html — click on "Exposure History Sheets in MS Word" in the scrolling menu located in the mid-

dle of the page). The different components (Community, Home and Hobby, Occupation or School, Personal habits, Diet and Drugs) can be printed on coloured paper for easy identification in patient charts. The questionnaire may be given to a patient to complete at home and bring to the next appointment for review and interpretation.]

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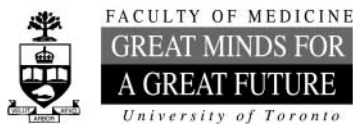
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**Correspondence to:** Dr. Lynn Marshall, Medical Director, Environmental Health Clinic, Sunnybrook & Women's College Health Sciences Centre, Rm. 538, 76 Grenville St., Toronto ON M5S 1B2

## Additional resources

- *Case studies in environmental medicine: taking an exposure history*. Atlanta: Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services; 1992. Available: [www.atsdr.cdc.gov/HEC/CSEM/exp/history/index.html](http://www.atsdr.cdc.gov/HEC/CSEM/exp/history/index.html) (revised Mar 2000; accessed 2002 Mar 22).
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