

## Workshop Report: Environmental Exposures and Cancer Prevention

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The Workshop on Environmental Exposures and Cancer was held by Cancer Care Ontario (CCO) 25–26 April 2001. An expert panel convened to achieve consensus on a list of important environmental exposures, priority environmental exposures in Ontario, and recommendations for CCO in the areas of surveillance, research, and prevention activities to address these environmental exposures. Panel members developed a working definition of environmental exposure and criteria to prioritize the identified exposures. The process followed in the workshop provided CCO with important direction for its surveillance, research, and prevention activities to address environmental exposures and cancer. It is hoped that the environmental exposures and the opportunities identified through this workshop process will guide policy makers, program personnel, and researchers interested in and struggling with the challenges associated with surveillance, research, and prevention of environmental exposures. *Key words:* cancer control, environment, exposure, prevention, research, risk, surveillance. *Environ Health Perspect* 111:105–108 (2003). [Online 9 December 2002] doi:10.1289/ehp.5384 available via <http://dx.doi.org/>

Cancer is the second leading cause of death in Ontario after cardiovascular diseases. The National Cancer Institute of Canada estimates that in Ontario 50,200 men and women will be diagnosed with, and 23,800 people will die from, cancer in 2001 (1). As the population grows and ages, and as techniques to detect cancer in its early stages are more systematically applied and improved, the number of people diagnosed with cancer will continue to rise. It has been estimated that, if current trends continue, the number of new cancer cases will increase by 40% by the year 2010 (2). Unless mortality rates for cancer decline as significantly as they have for cardiovascular diseases, cancer will likely become the leading cause of death in Ontario within a few decades.

Given the challenges that exist in treating cancer effectively (3), prevention strategies represent an essential part of cancer control. Effective prevention initiatives can decrease cancer incidence and mortality by  $\geq 50\%$  (4). The potential benefits of prevention initiatives are underscored by the knowledge that most cancers are caused by “environmental” (i.e., nongenetic) factors. The majority of such cancers are attributed to behavioral and lifestyle factors, viral agents, occupational exposures, and dietary factors. The proportion of cancers attributable to agents found in our physical environment (e.g., environmental pollutants, ionizing and nonionizing radiation) has been estimated to be relatively small,  $< 5\%$  of all cancers (5).

This comparatively low estimate of attributable risk should be interpreted with caution, however, in light of the methodologic problems of epidemiologic studies in assessing the

impact of environmental exposures and cancer risk—most notably problems in exposure measurement and identification of adequate control populations (6). The attributable risk of some environmental exposures will also be greater among some segments of the population, including those with gene polymorphisms that may leave them more susceptible to exposure effects. Moreover, the health risks of environmental contaminants are not limited to cancer risk.

Despite their seemingly low impact on the overall burden of cancer, environmental contaminants and ionizing and nonionizing radiation are a source of great concern to the general public. In a 1992 survey by Health Canada (7),  $> 90\%$  of respondents believed that the air, water, and land were more contaminated than ever before, and  $> 75\%$  responded that strict environmental regulation should continue. Survey respondents indicated a high level of concern over chemical products, pollution, nuclear waste, and ozone depletion and an unwillingness to accept some health risks to aid the economy.

Much of the public concern regarding environmental exposures focuses on the cancer burden, and the combination of pollution and cancer is, in the mind of the public, explosive. Spurred in part by public interest and in part by an acknowledgment that reduction of environmental exposure must be a component of a comprehensive cancer control strategy, the strategic plan of Cancer Care Ontario (CCO) recognizes the importance of environmental exposures vis-à-vis cancer in Ontario. Thus, CCO undertook the task of identifying its role concerning environmental exposures and cancer risk, with respect to the

potential areas of surveillance, research, and prevention. The process involved key informant interviews with research scientists active in the area of environment and cancer, followed by a 2-day workshop with a group of experts. The goal of the workshop was to develop consensus on priorities and recommendations for CCO regarding surveillance, research, and prevention.

### Key Informant Interviews to Identify Important Environmental Exposures

We conducted key informant interviews (8) with 14 scientists working in government, academia, and cancer control agencies in Canada, the United States, and Europe. The scientists, identified through a process of networking with individuals conducting research in the broad area of environmental exposures and health, represented the disciplines of human physiology, toxicology, epidemiology, environmental biology, occupational hygiene, environmental health, risk assessment, public health, and radiation biology. The key informant questionnaire (Table 1) was a semi-structured telephone interview, which asked respondents to identify the 10 most important environmental exposures.

All interviews were conducted by two of us, and the extensive notes were written in narrative form immediately after the interview. This procedure yielded more than 30 exposures, grouped into the following 13 areas (listed in alphabetical order): asbestos, combustion by-products, electromagnetic fields, endocrine disruptors, environmental tobacco smoke, medical/dental radiation, outdoor air pollution, persistent organic pollutants, pesticides, radio frequency waves, radon, ultraviolet radiation, and water disinfection by-products.

This list provided the basis upon which workshop participants could discuss, clarify,

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augment, and set priorities for CCO's work relating to environmental exposures. In this article we describe the results and recommendations of the workshop.

## The Workshop

The Workshop on Environmental Exposures and Cancer, held in Toronto on 25–26 April 2001, convened an expert panel of five scientists from academia and government in Ontario and Quebec, Canada, the United States, and Germany. Two of the panel members had participated in the earlier key informant interview process. Four scientists from within CCO were invited to attend as observers (Appendix 1).

## Goal and Objectives of the Workshop

The workshop's objectives were to achieve full consensus on a list of important environmental exposures, priority environmental exposures in Ontario, and recommendations for CCO in the areas of surveillance, research, and prevention activities to address these environmental exposures. Consensus was not difficult to achieve once the definition and assessment criteria were agreed upon.

**Workshop materials, structure, and agenda.** Before the workshop, participants were sent an agenda, a list of fellow participants, and copies of some relevant background reading (1,3–5). The preworkshop package also included a questionnaire containing the list of the potentially important environmental exposures in Ontario that derived from the key informant interviews. The questionnaire asked participants to make a professional assessment of the important exposures relevant to the role of CCO as a

provincial cancer control agency, with respect to surveillance, research, and prevention. Specifically, participants were asked to *a*) review and, if necessary, add to the list of environmental exposures provided by key informants that are a priority for Ontario; *b*) prioritize the list of exposures (and any exposures they added) in terms of their importance; and *c*) give their opinions regarding the next steps for action (surveillance, research, and prevention) for each of the priority environmental exposures.

Participants were asked to submit their completed questionnaires before the workshop so that the responses could be collated for presentation early in the discussion. The workshop agenda called for a full day to discuss and review the list of environmental carcinogens and to begin to develop a consensus on the list of priority exposures. The second day was reserved to complete the consensus process and to develop specific recommendations concerning the role of CCO to address surveillance, research, and prevention regarding environmental exposures and cancer.

## Results of Workshop

The workshop opened with a presentation on the context and rationale for CCO hosting a workshop on environmental exposures and cancer prevention. This was followed by a summary of the results of the preworkshop survey and general discussion of the list of environmental carcinogens generated through the key informant interviews. It became clear in this discussion that workshop participants needed to establish a working definition of environmental exposures before the participants could develop a list of exposures to discuss. Workshop participants also identified

the need to develop criteria to be used to prioritize the exposures.

**Defining "environmental exposures."** The panel of experts agreed to define "environmental exposures," for the purpose of the workshop, as "natural and anthropogenic chemical and physical hazards in air, water, soil, foods (i.e., food contaminants, not natural food toxins), consumer products, and our climate to which people may be exposed, usually involuntarily because of the need to eat, drink, and breathe in order to live" (9).

The working definition allowed for the inclusion of food contaminants such as pesticides applied to fruits and vegetables, but excluded diet itself. Lifestyle factors (smoking and physical activity), iatrogenic exposures (e.g., medical and dental radiation), and infectious agents were also excluded from the definition.

**Identifying important environmental exposures.** Based on the working definition of environmental exposures described above, consensus was achieved on the list of important exposures to be prioritized; Table 2 lists these exposures.

**Prioritizing environmental exposures.** A key discussion was the establishment of criteria to enable prioritization of the important environmental exposures. These criteria would subsequently be applied to the exposure list to derive relative rankings around which would revolve the discussion concerning recommendations. The panel first identified potential criteria for prioritizing the environmental exposures. Workshop participants subsequently discussed these criteria to derive a framework to prioritize the environmental exposures. The framework rested on deriving answers to four key questions:

- How strong is the evidence of an association between the environmental exposure and the occurrence of cancer?

**Table 2.** Consensus on important environmental exposures (in alphabetical order).

Asbestos
Benzene
Dioxins
Dump site contaminants
Electromagnetic fields
Endocrine disruptors
Environmental tobacco smoke
Fossil fuel radiation
Heavy metals
Other organic pollutants
Pesticides
Phthalates
Polycyclic aromatic hydrocarbons <sup>a</sup>
Radio frequency waves
Radon
Ultraviolet radiation
Volatile organic compounds (excluding benzene)
Water disinfection by-products (including trihalomethanes)
Working/living near nuclear power plants

<sup>a</sup>Plus other outdoor air pollutants and other combustion by-products.

**Table 1.** Key informant questionnaire.

I. From your perspective as a scientist, what are the ten most important environmental exposures which are known or may be causes of cancer in Ontario? These are exposures where you feel that someone should be generating\* ACTION and/or RESEARCH and/or PREVENTION activities. [This last sentence was modified in later interviews to ask about "generating\* RESEARCH and/or SURVEILLANCE and/or ACTION/PREVENTION activities."] Consider air, water, food, and dermal routes of exposure to humans as well as level and geographic extent of exposure, bioaccumulation, latent effects, potential for health effects in Ontario which may or may not be confirmed links in cancer aetiology.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_
8. \_\_\_\_\_
9. \_\_\_\_\_
10. \_\_\_\_\_

II. (a) Roughly, how would you rank these and why do you think these areas are important, specifically in relation to Ontario?

(b) Where ACTION is appropriate, what level(s) of action would you suggest for these areas?

III. What other agencies or groups are you aware of that might be doing this kind of investigation/prioritizing?

IV. Can you suggest other scientists with whom we should speak?

- How large is the problem relating to the exposure (e.g., prevalence of exposure, incidence of outcome, and magnitude of effect)?
- Is there public concern or pressure for a response regarding control of exposure levels?
- How does this apply to Ontario?

These key questions were answered for each of the environmental exposures identified in Table 2 to produce a list of exposures, prioritized for further consideration: ultraviolet radiation; environmental tobacco smoke; polycyclic aromatic hydrocarbons, other outdoor air pollutants, and other combustion by-products; asbestos; water disinfection by-products; electromagnetic fields; endocrine disruptors; radon; pesticides; radio frequency waves; dump site contaminants; and heavy metals.

Other exposures listed in Table 2 were deleted from further consideration during the prioritization process.

**Recommendations for surveillance, research, and prevention activities.** Recommendations were framed as either generic to any environmental exposure or specific to a particular exposure or group of exposures.

The generic recommendations for surveillance initiatives were to *a*) identify and become knowledgeable about existing surveillance

initiatives and databases (e.g., water quality, environmental tobacco smoke, emissions, dump sites) and *b*) design and implement new surveillance initiatives targeting exposures that are not currently monitored (e.g., radon, asbestos, dump sites, electromagnetic fields, pesticides, and heavy metals). These new initiatives might be as simple as adding relevant questions to existing population surveys.

The generic recommendations for research were to *a*) conduct literature reviews to determine the strength of the evidence regarding specific environmental exposures and to identify opportunities for further research and *b*) monitor research in the areas of electromagnetic fields, endocrine disruptors, and radio frequency waves.

The generic recommendations for prevention were to *a*) develop partnerships with organizations with common interests and objectives; *b*) assist with the evaluation of environmental exposure prevention programs implemented by other organizations; *c*) identify and communicate new evidence about environmental exposures and cancer to other organizations and stakeholder groups; and *d*) provide technical support to organizations and stakeholder groups, as required.

Specific recommendations also arose, tailored to the needs around particular exposures and focused on surveillance, research, or prevention. These recommendations are shown in Table 3.

## Discussion

The main result of the workshop on environmental exposure and cancer prevention was to provide concrete guidance for CCO on how to focus its attention productively on important environmental exposures. Workshop participants were invited to make recommendations in the context of surveillance, research, and prevention initiatives, recognizing that CCO must determine, based on its resources and capacity, the extent to which it can develop and implement these initiatives.

Workshop participants were able to identify important environmental exposures possibly associated with cancer risk in Ontario. In order to do so, they developed a working definition of environmental exposures. It is important to acknowledge that this definition may be incomplete or may not be acceptable to all scientists, policy makers, and program personnel working in the field of environmental exposures and cancer (e.g., early in the

**Table 3.** Exposure-specific recommendations to Cancer Care Ontario concerning surveillance, research, and prevention of environmental exposures and cancer.

Environmental exposure	Surveillance	Research	Cancer prevention activity
Ultraviolet radiation	Collect more data on sun-protective behaviors, outcomes (e.g., nonmelanoma skin cancer), and markers (e.g., nevi in children)		Work with Health Canada, Environment Canada, the Canadian Cancer Society, school boards, and municipalities to deliver sun safety programs and evaluate sun safety programs
Environmental tobacco smoke	Monitor temporal trends in ultraviolet index Support existing surveillance initiatives at the local, regional, and national levels	Conduct surveillance using exposure biomarkers such as cotinine levels in the general population	Communicate/disseminate scientific evidence to professionals Advocate for the banning of environmental tobacco smoke in the workplace; communicate to partners/stakeholders regarding successful initiatives
Polycyclic aromatic hydrocarbons	Estimate the number of cancer deaths attributable to polycyclic aromatic hydrocarbons	Develop improved exposure estimation	Advocate for cleaner engines
Asbestos			Support workers and businesses in building trade to reduce exposure; support initiatives to identify buildings with asbestos
Water disinfection by-products	Monitor water quality at treatment plants		Advocate for improvements to the Ontario Drinking Water Surveillance Program
Radon			Communicate information regarding risk of cancer from exposure to radon to partners, stakeholders, and the public concerning areas in Ontario with higher natural radon levels
Pesticides	Monitor pesticide use		Communicate results of studies regarding the risk of cancer from exposure to pesticides to partners, stakeholders, and the public
Dump site contaminants		Link point-source exposures from dump sites to cancer registry data	
Heavy metals	Work with the Ministry of Labour and other stakeholder groups to monitor exposure in industrial sites		

process, some key informants had identified high-fat diet and sexual activity as “environmental” exposures). Finally, different criteria than those identified by the workshop participants might be used to rank environmental exposures and cancer risk.

This process has enabled a substantial reduction of the number of environmental exposures requiring consideration by a cancer control agency. Professional assessment and consensus, rather than quantitative meta-analysis, is a highly efficient and effective means of directing attention to *a*) a limited (and manageable) number of high-priority exposures, among the myriad possible “contenders,” and *b*) the activity (surveillance, research, prevention) required at present for each of the exposures. Given finite public health resources, it is necessary for a public agency to follow a somewhat restricted path, one that offers the greatest probability of yielding new knowledge and new public policy. It is interesting that the literature has been rather silent on these issues, even as public agencies, including those devoted to cancer control as well as those more broadly involved with public health, struggle to identify important exposures and actions to reduce their impact.

The priority environmental exposures that emerged from the workshop passed a test of “face validity,” and consensus was obtained from this diverse group of scientists. As new evidence emerges, the list of environmental exposures may (and likely will) change, precipitating renewed discussion of the emphasis placed on these exposures with respect to the activities of surveillance, research, and prevention. Thus, there is a need to establish a process by which CCO may identify new carcinogens, rather than to assume that a one-time workshop can provide all the answers.

The incidence of cancer is increasing in Ontario, and there is substantial public concern over the extent to which the environment plays a role in the onset of cancer. A

number of community-based organizations have adopted position statements for public education on environmental contaminants and cancer risk (10,11). The process followed in the workshop provided CCO with important direction for its surveillance, research, and prevention activities to address environmental exposures and cancer, as the beginning of a multistage project. Activities are under way within CCO to review the literature on the identified environmental exposures and cancer risk, with a view to focusing more closely on specific opportunities for activities in surveillance, research, and prevention in conjunction with other interested agencies. It is hoped that the environmental exposures and the opportunities identified through this workshop process will guide policy makers, program personnel, and researchers interested in and struggling with the challenges associated with surveillance, research, and prevention of environmental exposures.

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#### Appendix 1. Participants of the Environmental Exposures and Cancer Prevention Workshop, Cancer Care Ontario, 25–26 April 2001.

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