



Health Policy Research

Bulletin

Health and the Environment: Critical Pathways

Over the years, public health and environmental policies aimed at reducing environment-related disease have contributed to significant improvements in the health status of Canadians. Despite these advances, however, health problems as a result of exposure to environmental contaminants remain a serious concern for many Canadians. This is especially true for certain populations who, because of their stage of physical development, or their living and working conditions, are at greater risk than the general population. A growing concern for many Canadians is the cumulative effect of long-term exposure to low doses of environmental contaminants.

While “the environment” in its broadest sense has important influences on human health, this issue of the *Health Policy Research Bulletin* focuses on the health impacts of the “physical environment.” More specifically, it explores the range of research and evidence required to effectively assess and manage environmental health risks including, for example:

- developing environmental health indicators and ensuring that appropriate surveillance systems are in place
- identifying potential environmental threats and assessing the associated health risks
- determining the pathways and mechanisms of exposure and identifying potential points for intervention ▶

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Depending upon the evidence, options for managing the risks associated with potential environmental threats may vary from minimum-level interventions (e.g., increasing public awareness) to maximum-level interventions (e.g., legislation banning the release of a substance into the environment). A case study on developing regulations aimed at limiting the sulphur content in gasoline provides a good illustration of how research can be used to help manage environmental health risks. 

Environmental Health Legislation

Health Canada is involved in administering, in whole or in part, 20 pieces of health-related legislation. An overview of some of the key legislation aimed at protecting and promoting environmental health is provided below. A more complete list of relevant legislation can be found at: http://www.hc-sc.gc.ca/english/about/acts_regulations.html


Responsibility of Environment Canada and Health Canada

- **Canadian Environmental Protection Act (CEPA):** governs pollution prevention and protection of the environment and human health, all within the context of sustainable development goals

Responsibility of Health Canada

- **Hazardous Products Act (HPA):** prohibits the advertising, sale and importation of hazardous products
- **Food and Drugs Act (FDA):** ensures the safety of food, drugs, cosmetics and therapeutic devices
- **Pest Control Products Act (PCPA):** governs the importation, manufacture, sale and use of pesticides

Responsibility of Environment Canada

- **Canadian Environmental Assessment Act (CEAA):** ensures all new projects with federal involvement include an environmental impact assessment, including an assessment of human health impacts 

About the Health Policy Research Bulletin

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Health & Environment

A Policy Nexus

The following article is based on an interview with **Rod Raphael**, Director General of the Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada. The interview was conducted by Nancy Hamilton, a Managing Editor of the Health Policy Research Bulletin.

Q This issue of the Bulletin examines the relationship between two important areas — health and the environment. What is a good starting point for understanding this relationship?

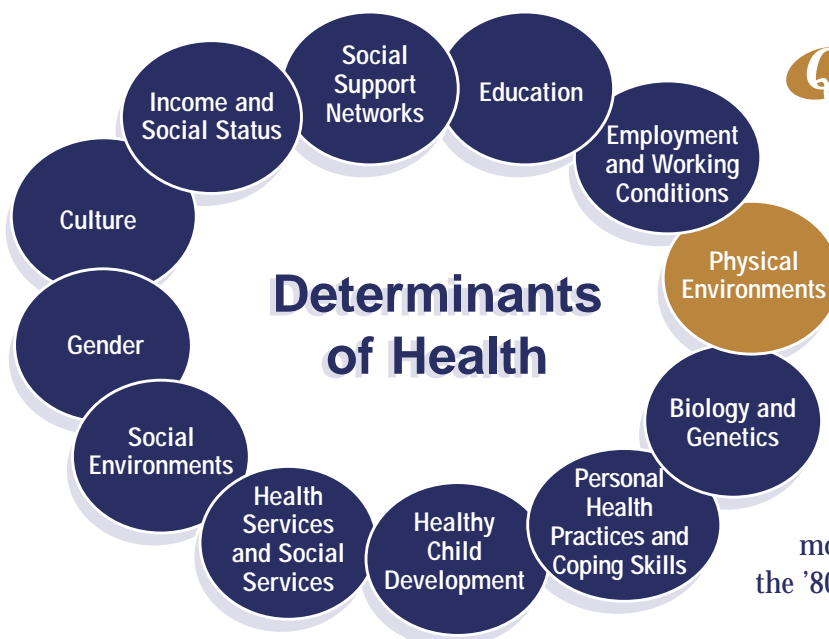
Health and the environment are two very important, intertwined areas of policy. From a health policy perspective, our starting point is a recognition that the “environment” is one of several determinants of health. Our health — in fact, our very survival — depends on the environment, from the air we breathe, to the water we drink and the food we eat. When any of these is threatened, human health is compromised. This is the starting point from which health departments work to identify, reduce and prevent environment-related health risks.

Q When you say that the environment is a determinant of health, how would you define “environment?”

In its broadest sense, environment refers to the physical, social, cultural and economic attributes of our surroundings. While all of these have important influences on human health, the “physical environment” has been identified within the **determinants of health model** as one of 12 interrelated health determinants. So, for our discussions here, we’ll focus on the impacts of the physical environment on human health. However, regardless of what we understand the environment to be — air, water, soil, trees, the biota and so on — human health depends on a well-functioning environment and harmonized ecosystems.

Q Recognizing that the physical environment is a determinant of health, in what ways does it affect our health?

The physical environment can influence our health through the direct impacts of naturally occurring substances within the environment and also as a consequence of our individual and collective interactions with the environment. As a society, we use the natural resources within our environment for purposes of economic and social development. Consequently, we have to consider the primary, secondary and tertiary impacts of development on human health, most of which stem from — in the terminology of the ’80s and ’90s — a polluted environment. ▶



Q *How can we measure the impact of the environment on human health?*

Being able to measure the impact of the environment on human health is an important public policy challenge and one that requires a much greater investment than we have given it so far. We need to understand the risks and benefits associated with various courses of action so we can make policy decisions that favour human health. One way to do this is to identify variables/indicators or proxy variables/indicators that can help us understand how human health and systems are affected by our interactions with the environment. We've made progress in some areas. For example, with respect to the relationship between air quality and cardiorespiratory diseases, we've been able to measure trends using some rough indicators of illness and disease, including mortality and morbidity analyses (see article on page 9). But, we have a long way to go! We often focus on acute situations and fail to recognize the underlying chronic dimensions that must be taken into account.

Q *How can research inform policy development with respect to health and the environment?*

Policy development in the area of health and the environment is evidence-based. We use the scientific method to understand the ecological processes that are being disturbed and the actions that can be taken to prevent or mitigate their impacts or to avoid them in the first place. This is a monumental research effort involving scientists in Health Canada and other government departments, as well as those in academic institutions and private corporations.

A critical issue relates to the *precautionary principle* and the role that research plays in the development of public policy. Applying the precautionary principle within a risk management framework means that, in situations where serious or irreversible health threats exist, action is justified even in the absence of full scientific certainty. For example, in the area of children's environmental health, we may not know all of the pathways by which environmental factors affect the developing physiology of a child, and yet we make decisions to act based on rudimentary information with the belief that society expects us to protect children's health from environmental

insults. It's important to remember that the availability of evidence is not the sole determinant of policy action. Social values also play an important role.

Q *What is the current status of the evidence base on the effects of the physical environment on human health?*

While we've made progress, the evidence base in many areas is still fairly new, especially with respect to the cumulative effects of long-term exposure to environmental change. For example, an evidence base is only now emerging about the endocrine-disrupting effects of chemicals that have entered the environment as a result of 20th century development (see article on page 5). In other areas, the evidence base is more mature. For example, we know there is tremendous diversity within the human population, including an underlying genetic diversity that can lead to predispositions to certain types of reactions to environmental factors. Consequently, some people are more sensitive than others to factors within the environment. It is also clear that we go through phases of heightened sensitivity during our lives, from early childhood through to adolescence, during pregnancy and as we age (see article on page 13).

There is also a growing body of research exploring the pathways of exposure by which the environment-health link works. We know, for example, that one's health risk to a substance in the environment depends on more than individual sensitivity; it depends on how concentrated the substance is and the pathways or mechanisms of exposure. Understanding such pathways is critical to eliminate or control the associated health risks.

As a result of exciting developments in an area that might be called "molecular epidemiology," we're beginning to understand more about the subtle, but long-lasting effects at the level of the genome. While evidence of these chronic, potentially cross-generational impacts is building, it is not at the same level as evidence of acute impacts of short-acting toxic materials. Nevertheless, improved surveillance techniques at the population level and our growing capacity to analyze surveillance data at the molecular level are contributing to a rapidly growing evidence base in this promising new area. 🌱

Healthy Environments

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Healthy People

Anthony W. Myres, PhD, *Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada*, and **Katherine Betke**, *School of Applied Biology (Co-op Program), University of Victoria*

In this overview of the link between the environment and health, the authors focus on the role of the physical environment as a determinant of health. They trace the evolution of knowledge about how elements of the physical environment affect health and introduce some key considerations in assessing and managing environmental health risks.

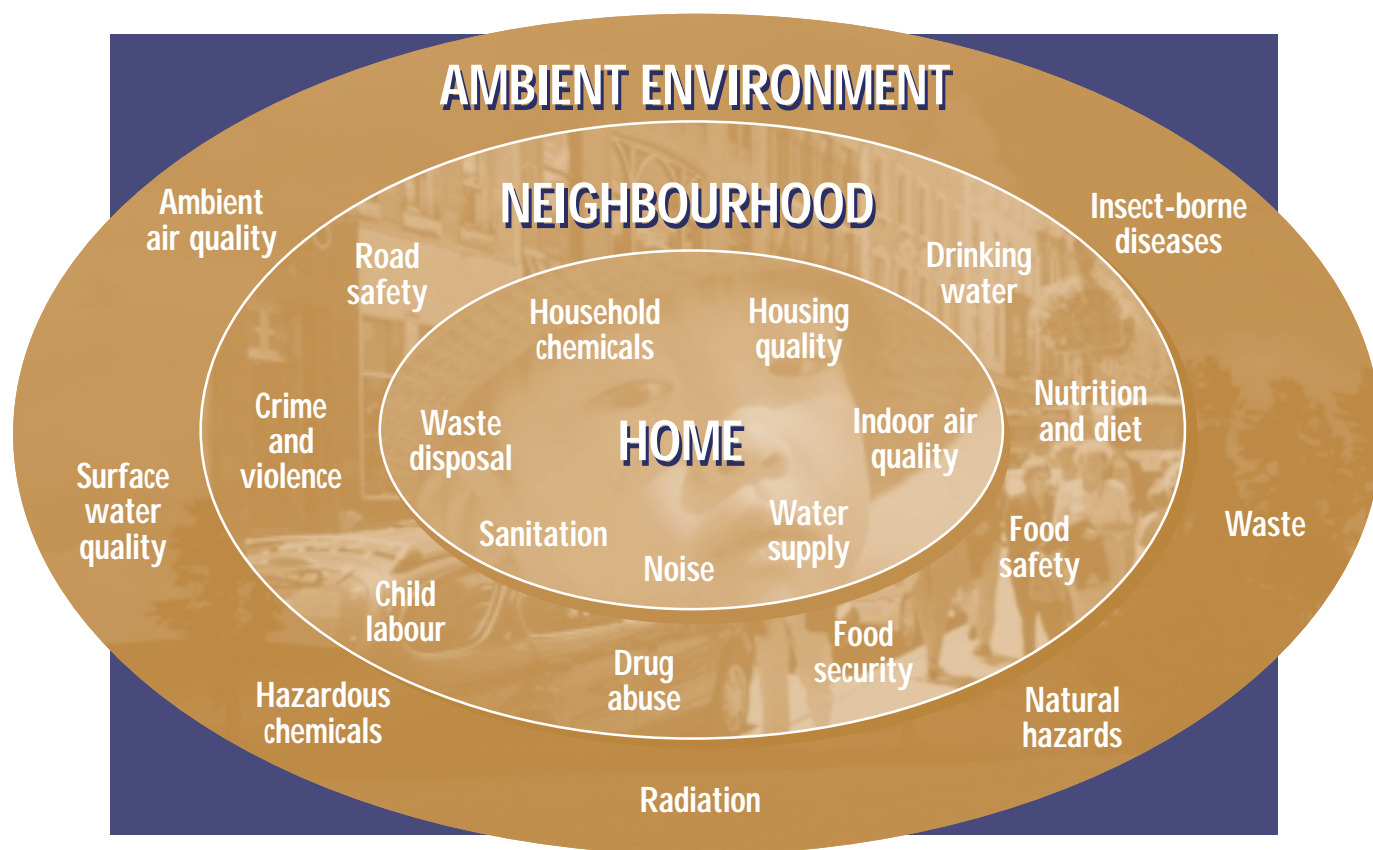
The Environment — A Determinant of Health

“The environment is everything that isn’t me.” (Einstein)

This statement not only underscores how pervasive “the environment” actually is, it also alludes to the difficulty of establishing causal links between specific elements in the environment and their impact on health. According to the *Canadian Environmental Protection Act* (CEPA), the federal government’s key environmental protection legislation, the environment includes “. . . the components of the Earth, including: the air, land and water; all layers of the atmosphere; all organic and inorganic matter and living organisms; and the interacting natural systems that include components referred to in the latter.”¹

From a human health perspective, the term **environmental health** is even broader, encompassing all aspects of human health, disease and injury that are determined by factors in the environment. These factors include the direct pathological effects of chemical, physical and biological agents, as well as the health effects of the broad physical and social environment (e.g., housing, urban development, land use and transportation, industry and agriculture).² This concept of environmental health — as established by the World Health Organization (WHO) — is illustrated in Figure 1.

The concept of **health** has also expanded over the years, beginning with the WHO’s 1948 assertion that “health is not merely the absence of disease but a state of complete mental, physical, emotional and spiritual well-being.” A significant break with past thinking, this broader understanding of health continued to evolve, first making inroads in Canada with the publication of *A New Perspective on the Health of Canadians*.³ This report marked the first time a major government document acknowledged that the influences on health extended beyond health care to include human biology (genetic factors), living habits (lifestyle) and the environment. ▶

Figure 1: **Environmental Influences on Health**

The Changing Nature of Environment-Related Disease

While a holistic approach to public health may be relatively new, the connection between health and the environment — in the narrower sense of clean air and water, and safe and nutritious food — has long been known. Advances in these areas have been largely responsible for the significant improvements in public health in Canada over the past century. However, many of these environmental health concerns are still serious problems among Canada's First Nation communities (see article on page 15).

Despite recent advances, Canadians are worried about the impact of the environment on their health. One of the main reasons is the perception that environmental health problems are increasing and adversely affecting their health now. Almost two thirds of Canadians believe their health is affected by the environment, and a similar proportion view environmental pollution as posing the greatest threat to future generations (compared to 9 percent who viewed “wars and conflict” as the greatest threat).⁴

This raises an interesting paradox since, by all the established measures of public health (e.g., infant mortality, life expectancy), Canadians have never been healthier. Yet, serious problems remain. For example, the incidence of children's asthma, which is certainly exacerbated by poor air quality, has increased fourfold since the 1970s.⁵

The Chemical Revolution

One growing environmental concern is the proliferating use of chemicals in industry, agriculture and consumer products — a chemical revolution that is said to rival the significance of the Industrial Revolution. While many industrialized societies now depend on chemicals to maintain their standard of living, there are increasing concerns about related health hazards, particularly long-term exposure to low levels of chemicals and the adverse effects on the developing foetus, infant and young child (see article on page 13).

The 1962 publication of Rachel Carson's *Silent Spring* first drew public attention to environmental

pollution caused by the indiscriminate use of pesticides.⁶ This work and the later environmental movements it spawned, helped galvanize governments in Canada and the United States to establish departments of the environment and to enact legislation to protect the environment.

The Federal Response

Environmental legislation in Canada is a shared responsibility between the Ministers of the environment and health, with the Environment Minister maintaining overall administrative responsibility. The country's first environmental protection legislation was the 1974 *Environmental Contaminants Act*, a forerunner to the more comprehensive *Canadian Environmental Protection Act* (CEPA), 1988, which was significantly amended in 1999. Under CEPA, the government has successfully put into place controls on environmental hazards — for example, phasing out the use of ozone-depleting substances, the emission of dioxins and furans from pulp mills using chlorine bleaching and the use of lead and sulphur in gasoline (see article on page 19).

As outlined on page 2, Health Canada has additional responsibility for a wide range of legislation designed to protect and promote the health of Canadians. Four of these Acts are of particular importance for protecting public health from chemical risks, either by controlling the level of hazardous substances in a product, or by controlling substance emissions at their source.

Sustainable Development: Linking Environment, Health and Economy

The link between health, the environment and the economy came into international focus in 1987 when the Brundtland Commission defined sustainable development as “that which meets the needs of today without compromising the ability of future generations to meet their own needs.”⁷ In 1995, the federal government officially adopted both pollution prevention and sustainable development as elements of its policy agenda. By 1997, all federal departments were required to develop and implement sustainable development action plans demonstrating the social, economic and environmental factors taken into consideration in their decision making.⁸ An overarching federal strategy on sustainable development is currently in development.

Risk Assessment and Risk Management

“There is no safety without risk.” (Wildavsky)

Recognizing that a completely risk-free environment is not an achievable goal, governments need a systematic decision-making process to determine the level of risk that is acceptable both to the environment and to public health. A number of frameworks have been designed over the years, all of which include the following core steps: identify the hazard; characterize and quantify the risk; develop options for controlling the risk; implement the control measures (risk management); and evaluate. Health Canada's current approach to decision making incorporates these steps.⁹ It should be noted that, although this decision-making process appears simple, it includes a number of important constraints, such as the need to:^{10,11}

- extrapolate from evidence derived at high doses to determine risk at lower doses
- extrapolate from animal data to human risk and from past or current data to future generations
- allow for the effects of exposure to complex mixtures of chemicals and their interactions
- define and value the quality of life

The Role of Science

“When you cannot measure it . . . your knowledge is of a meagre and unsatisfactory kind.”

(Lord Kelvin)

The goal of hazard identification, risk assessment and risk management is to identify a course of action that is not only scientifically sound, but also cost effective and integrated. In other words, risks are reduced while taking into account key social, cultural, ethical, political, economic and legal considerations. Although scientific input is important, establishing an unequivocal cause-effect relationship is a long and difficult process, and there are always uncertainties. As a result, discussions of environmental and health protection over the past quarter century have given increasing attention to an approach that is guided by the “precautionary principle.”

The most widely-accepted definition of the precautionary principle is one endorsed at the Earth Summit in Rio in 1992. The *Rio Declaration* states that: “Where

there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.” The CEPA has adopted this definition and it is now the explicit duty of the Government of Canada to implement the principle.

Similarly, Health Canada’s first *Sustainable Development Strategy* recognizes the need to apply the precautionary principle as a means of preventing serious and irreversible impacts on human health.⁸ This does not mean taking action in the absence of evidence but, rather, ensuring that the quality and the weight of the evidence is taken into account even though it falls short of scientific “proof.” Nor does it mean automatically assuming the “worst case” scenario, an approach that may result in inefficiencies or wasting scarce resources that might otherwise be used to address more pressing problems.

Clearly, it is possible for people to become exposed to any substance in the environment. The question is: “What is the risk that exposure will cause harm?” (risk assessment). The corollary is: “What can be done about it?” (risk management). The harm that is done to human health is a function of the inherent toxicity (hazard) and the degree of exposure (i.e., the concentration or dose and the length of time exposed).

Hazard is a property of the chemical or substance, **susceptibility** is a property of the organism being affected by the chemical (in this case, human beings) and **exposure** is a property of the intervening environment (i.e., the environment, from the point where the chemical is released and along its pathway to humans). **Risk** is a measure of both the hazard and the

probability of its occurrence (see Figure 2). To illustrate, consider crossing the ocean in a boat — either an ocean liner or a row boat. The hazard (of drowning) remains the same, but the risk is considerably reduced in an ocean liner because the probability of exposure, compared to a row boat, is minimal.

Over 400 years ago, Paracelsus observed: “All things are poisons, for there is nothing without poisonous qualities. It is only the dose that makes a thing a poison.” This presents a profound truth — overexposure to any substance can threaten health. Because the level of harm depends on the level of exposure, it is a continuing challenge to determine through **risk assessment** the level of exposure to particular substances — including food, water, air and consumer products — that will result in increased risks to health. **Risk management** options cover the full spectrum, from minimal intervention (e.g., enhancing public awareness) to maximum intervention (e.g., a ban).

Future Challenges — Finding the Right Balance

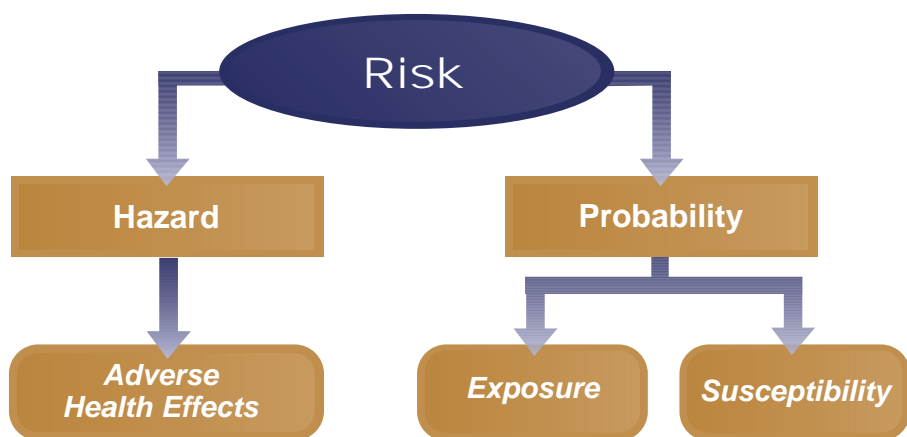
Science will continue to play the primary role in establishing the evidence base for decision making, particularly with respect to identifying environmental hazards and their links to health outcomes. Together with Health Canada, the Canadian Institutes of Health Research (CIHR) is taking a leadership role in developing a national research agenda on the environmental influences on health that is aimed at strengthening the research base over the next 10 to 15 years. However, the need for additional research does not necessarily

mean postponing action. The British medical statistician, Sir Austin Bradford Hill,¹² who wrote a classic text on causality and disease, highlights the challenge of achieving an appropriate balance:

“All scientific work is incomplete. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time.”

@ [Click here for references.](#)

Figure 2: What is Risk?



Environmental Health Indicators

Sabit Cakmak and Sheryl Bartlett, *Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada, and Paul Samson, recently with Environment Canada*

Environmental Health Indicators (EHIs) are important tools for assessing the impact of environmental factors on human health. Health Canada is currently collaborating with other federal departments to develop a set of EHIs for use in Canada. This article examines the need for such indicators and presents a framework for navigating the complexities of the indicator development process.

Introduction

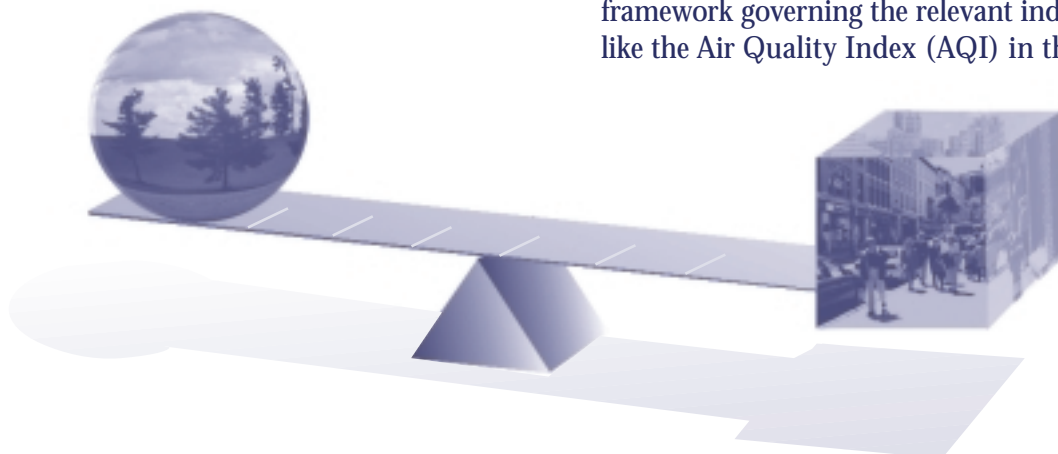
Individuals, corporations and governments have come to rely on economic indicators such as the Gross Domestic Product (GDP), the inflation rate and the unemployment rate to help guide their decision making. Spurred by the widespread use of such economic indicators, international organizations and governments at various levels have initiated a range of projects focussing on the development of indicators in the social and environmental fields (see also “Who’s Doing What?” on page 23). To ensure that these new indicators serve the varied needs of researchers and policy makers, they must meet a number of important criteria.

What are Indicators?

Environmental indicators are important measures of phenomena that may pose a threat to the natural environment as well as to living organisms. Environment Canada’s Indicators and Assessment Office defines **indicators** as statistics or parameters that, tracked over time, provide information on trends in the condition of a phenomenon.

Environmental indicators are key statistics that represent or summarize a significant aspect of the state of the environment. They focus on trends in environmental changes, as well as on the stresses causing these trends, how the ecosystem and its components are responding to the changes, and what society is doing to prevent, reduce or ameliorate the stresses. A significant challenge in developing useful environmental indicators lies in achieving a balance between scientific accuracy and simplicity. Often, the difficulty lies in aggregating complex data into simple summary indicators, particularly if there is no overarching conceptual framework governing the relevant indicators. Environmental indicators like the Air Quality Index (AQI) in the box on page 10 provide only

indications of health risks, as no direct links between indicators and health have been established. Therefore, **environmental health indicators** (EHIs) are being developed to measure the relationship between the environment and health. ▶



An Environmental Indicator

The Air Quality Index (AQI), which relates pollutants to National Ambient Air Quality Objectives (NAAQO), is an example of an environmental indicator that strives to achieve a balance between scientific accuracy and simplicity. The AQI is based on measures of pollutants that have adverse effects on human health and the environment, including sulphur dioxide, nitrogen dioxide, ozone, total reduced sulphur compounds, carbon monoxide and suspended particles measured as the coefficient of haze. Every hour, the concentration of each of these pollutants at a particular site is converted to a number on a common scale or index. The value for each pollutant is called a sub-index and the pollutant with the highest value determines the AQI for that time period, at that site. The lower the AQI, the better the air quality.

EHIs: Indicators of a Relationship

Environmental health indicators are measures of health status attributable to the physical environment. Because people can relate to many of them (e.g., indicators of mortality, disability), EHIs are often better understood than environmental indicators. EHIs are also more amenable to aggregation because established methodologies exist for weighting different health states (e.g., losing lung capacity versus getting cancer). As well, EHIs serve as useful adjuncts to environmental indicators, as they can provide “macro” corroborating (or not) evidence about environmental developments — for example, air quality is improving and air quality-related health problems are diminishing.

Air pollution is an example of an environmental problem that has been identified as having health consequences. Bell and Davis¹ recently reassessed data on the health consequences of a lethal fog episode during the winter of 1952 in London, England. They estimated that 12,000 deaths occurring from December 1952 through February 1953 were due to acute and persisting effects of smog (Figure 1 shows the effect of pollution on mortality during December 1952). Air pollution levels for the period were 5 to 19 times above current

(i.e., 2002) regulatory standards and guidelines, as well as levels in some rapidly developing regions of the world.¹ Since that study, similar associations have been found in studies of other metropolitan areas — for example, ambient levels of particulate matter have been linked to daily mortality rates for the period 1986–94 in Toronto, Canada (see Figure 2).

How Are EHIs Developed?

In developing EHIs, consideration must be given to the nature of the relationship between a factor in the environment and its impact on health. In this regard, an analytical framework is essential in classifying EHIs along the cause-effect continuum.

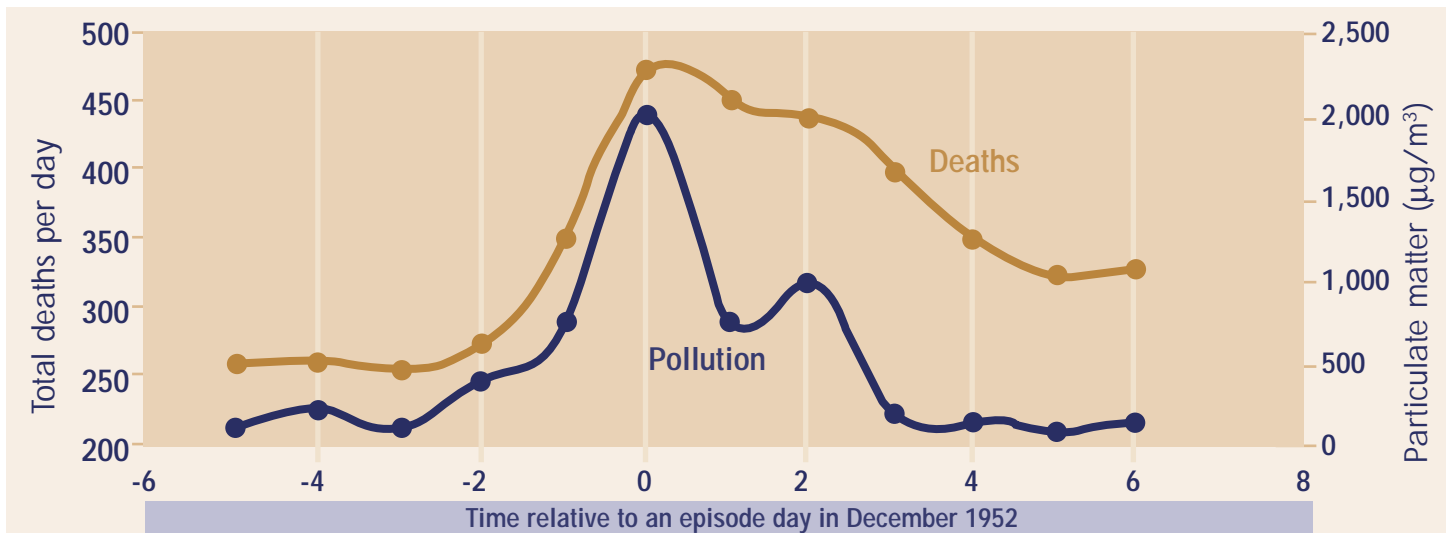
Frameworks: A Necessary Starting Point

In designing EHIs, a major concern is the ability to link the impact of the environment to health status, ideally as a cause-effect relationship. Unlike the above examples, however, information may be available on either exposure or health status, but not on both. In addition, the links between exposure and health status may be tenuous and, as a result, findings must reflect this uncertainty. For these reasons, it is important to use an analytical framework in developing EHIs, so that indicators may be classified along the cause-effect continuum.

Several such frameworks have been proposed, most of which are derived from the Pressure-State-Response (PSR) framework. For example, the World Health Organization (WHO) has expanded the PSR framework to capture the crucial linkages involved in assessing environmental health. The resulting approach, entitled the Driving Forces, Pressure, State, Exposure, Effects, Action (DPSEEA) model, provides a broad starting point from which a set of specifically tailored national indicators can be developed.² While the model offers a “big picture view,” it also focuses attention on individual components — **state**, **exposure** and **effects** — that are key to determining the environment-health relationship.

The issue of air quality illustrates how the DPSEEA Framework and its elements were used to construct an EHI linking air quality and health. Following are the “core” indicators representing the respective elements of the framework as they relate to air quality:

- urban density/sprawl and the volume and type of road traffic (**driving forces**)

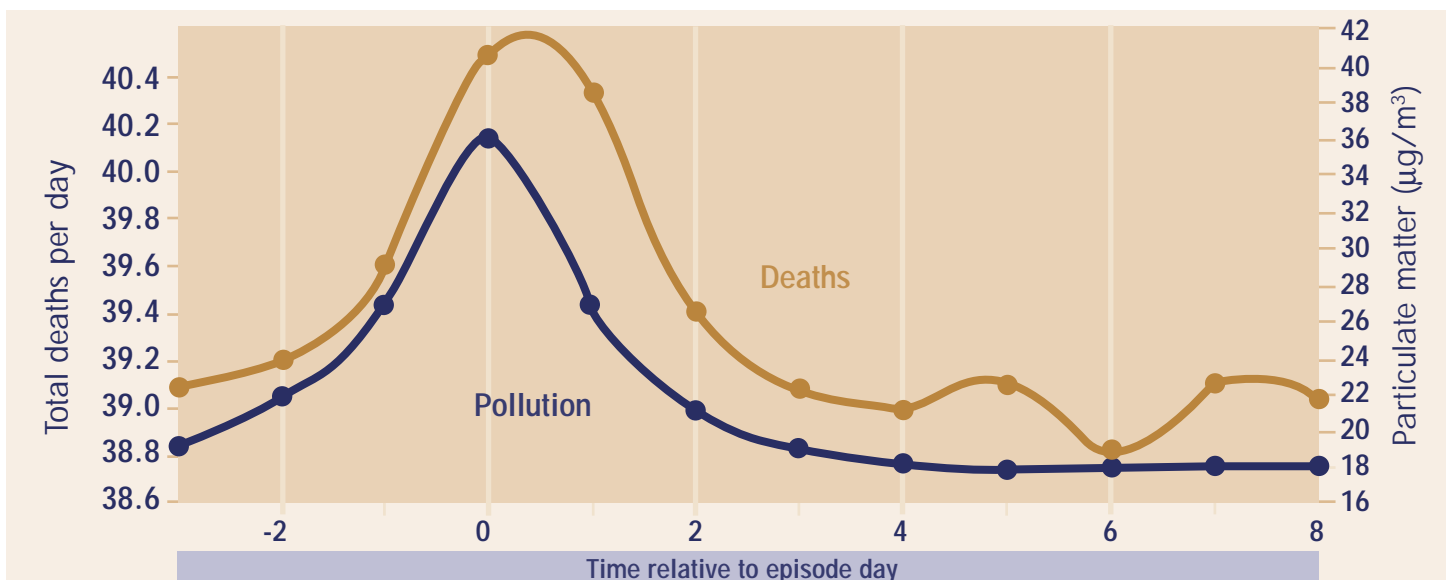
Figure 1: **Effect of Pollution on Mortality, December 1952, London, England**

Note: In Figure 1, day zero on the x-axis represents an episode day of high air pollution in December 1952.

- emissions of air pollutants (**pressure**)
- ambient concentrations of air pollution, i.e., concentration of PM_{2.5}, PM₁₀, ozone, etc. (**state**)
- population exposure to pollution in excess of maximum acceptable levels (**exposure**)
- population mortality/morbidity due to respiratory or cardiorespiratory disease (**effect**)
- agreements, initiatives, and programs (**action**)

Choosing Themes and Issues

EHIs are currently being developed on the following broad themes: air and atmosphere; water and aquatic systems; land and land cover; and food and food products. While EHIs are useful to consider on their own, they are only one part of the broader picture of sustainable development. To be effective, indicators need to: be built around clear, specific goals; consider the ambient physical and social environment; and be embedded within a sustainable development context.³

Figure 2: **Effect of Pollution on Mortality, 1986–94, Toronto, Canada**

Note: In Figure 2, day zero on the x-axis represents the average episode day of high air pollution in 1986-94 in Toronto, Canada.

Criteria for Selecting Indicators

Much has been written about the criteria for selecting indicators. For example, the OECD's foundation work on indicators⁴ discusses both **technical/scientific** and **user/policy** elements as criteria. **Scientific-based criteria** include data availability and sustainability, validity, representativeness, reliability and the ability to be broken down into other variables. **User-based criteria** for indicators include the feasibility of access and the relevance of the indicator to those affected.

Indicators should also be scientifically sound, robust, easily understood, sensitive to the changes they are meant to represent, measurable and capable of being updated regularly.⁵

An Example of an EHI: Making the Air Quality-Health Link

The primary motivation for reducing air pollutant levels is to protect population health. However, the Air Quality Index (AQI) cannot actually tell the magnitude of the impact of exposure to air pollutants on health. Burnett et al.⁶ have proposed an environmental health indicator that makes a direct link between air quality and health. This indicator measures improvements in population health, based on reductions in ambient fine particulate matter over time. It is a function of several factors — including temporal changes in site-specific ambient concentrations and the relationship between those concentrations and daily mortality or hospital admissions rates for heart and lung problems. The new indicator, which is based on a methodology used in a number of epidemiological studies, can be determined for a single location, or at the regional or national level, and can also be expanded to include several pollutants. It is even possible to extend the methodology so that the annual number of deaths attributed to fine particulate exposures can be tracked over time across Canada.

EHIs: How Can We Use Them?

The potential negative impact of the environment on human health has long been a policy concern. There is widespread agreement that access to valid and relevant information about local and national health

impacts of environmental hazards is key to developing and monitoring policy in this area. EHIs offer a concise, effective and easily understood way of making such information available to public health agencies, decision makers and health professionals. Within this context, EHIs serve an important function in several key areas:

Identification of hazards/risks: EHIs can be used to monitor environmental health hazards, thereby helping to identify and investigate potential links between environmental factors and health effects.

Decision making and policy development:

EHIs can provide input into the decision-making process by monitoring health trends in the context of environmental exposure and risk factors.

Setting and evaluating program objectives:

Specific EHIs can be used to set program objectives that can then be tracked and re-evaluated over time — these performance measures can help in assessing the effects of various policies and interventions.

Accountability and environmental health reporting:

Federal departments and agencies play an important role in providing information to Parliament and Canadians. In the past, performance measurements have been based largely on subjective assessments rather than on

objective measures of the outcomes of various actions. Indicators provide a level of transparency in environmental reporting that was not previously possible.

Moving Forward

Environmental health indicators show significant promise as a means of credibly and transparently connecting science and policy. However, complex environmental health issues may require aggregating sets of indicators into indices. Researchers will need to respond to these needs by moving a step further to develop easily understandable indices for use in decision making by government policy makers, business leaders and members of the public. 🌐

@ [Click here for references.](#)

To be effective, indicators need to: be built around clear, specific goals; consider the ambient physical and social environment; and be embedded within a sustainable development context.



Vulnerable Populations

Critical Pathways

Anthony W. Myres, PhD

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In assessing environmental risks to health, it is important to recognize that people are not all alike, either in their level of exposure or their ability to detoxify. While the goal of public health is to protect the health of all, some subpopulations may be more at risk than others. Understanding the impact of environmental hazards on specific populations can result in concrete steps towards identifying, preventing, reducing and eliminating various health risks.

In Northern Communities

Many people living in the Canadian Arctic rely on a diet comprised primarily of fish and wild game. As a result, they may be exposed to relatively high levels of contamination, due to a cumulative buildup of contaminants higher in the food chain. The Northern Contaminants Program (NCP), which operates under the aegis of Indian and Northern Affairs Canada, addresses the issue of food contamination in northern diets. One of the principal tenets of the NCP is that risks must be balanced against benefits. Within this context, the current consensus is that the known nutritional, social and cultural benefits of consuming “country foods” (i.e., from fish and wildlife harvesting) outweigh the health risks of contaminants in these foods.¹ Health Canada plays a lead role in the NCP’s health program.

A number of other environmental issues have particular implications for people living in Canada’s North. For example, the Arctic climate acts as a condenser, creating a “sink” for pollutants such as Persistent Organic Pollutants (POPs — e.g., DDT, PCBs) that are conveyed by long-range transport. To address this issue, Canada played a lead role in developing the *UN Convention on Persistent Organic Pollutants* and was the first country to ratify the Convention.²

Throughout the Life Cycle

Research has also shown evidence of heightened sensitivity to environmental hazards at certain stages of human development:

Infancy and Childhood

Because their tissues and organs are undergoing rapid cellular development, infants and very young children are more vulnerable than adults to environmental hazards.³ While there is some debate about whether children are *always* more susceptible to chemical toxicity than adults,⁴ there is no doubt that infants have unique characteristics (metabolism, exposure patterns, behavioural features) and cannot be considered simply as “little adults.”⁵ Breast milk is one pathway through which children are exposed to environmental contaminants. As some contaminants can build up in breast milk (from those stored in the mother’s fat deposits), breastfed infants may be exposed to high doses of

contamination. However, the unique benefits of breastfeeding — nutritional, immunological, psychological and emotional — far outweigh the risks from contaminants, a conclusion that has been endorsed by health professionals and governments worldwide.⁶

Many of the major disorders confronting Canadian children today are chronic, disabling conditions sometimes referred to as the “new pediatric morbidity.” Besides injuries and obesity, the new pediatric morbidity includes increases in asthma, disorders of endocrine and reproductive development and neurodevelopmental dysfunction. Evidence shows that chemicals in the environment may be contributing factors to these conditions.⁷ Because healthy early child development is a prime determinant of later health, there has been an enormous international effort to make children’s environmental health a priority.⁸⁻¹²

Adolescence

Adolescence is another “window of vulnerability,” due to the rapid growth rate and the surge of hormones related to sexual development. Of particular concern are endocrine-disrupting substances (EDS), including a variety of organic and inorganic pollutants, that have the potential to interfere with hormones controlling growth, development, reproduction and the function of the immune and central nervous systems. While there is no conclusive evidence of human health risks due to current levels of EDS exposure, adverse effects have been documented in fish and wildlife, as well as on laboratory animals. Studies such as these suggest a number of possible effects on human health, including earlier onset of puberty, altered development of male and female reproductive tracts and reduced sperm production.¹³⁻¹⁵ Animal studies indicate that these effects are likely a consequence of earlier, possibly *in utero*, exposure.

The Reproductive Years

Environmental hazards can also affect fertility and pregnancy outcomes, as measured by rates of infertility, spontaneous abortion, chromosomal anomalies, pre-term delivery, low birthweight and stillbirths. Low dosage exposure of pregnant women to some toxic substances may affect neurophysiological and other

facets of fetal development at critical stages, resulting in later learning disorders or other conditions.¹⁶

Very little research has been done on the sex/gender-specific effects of exposures to toxicants such as pesticides and metals.¹⁷ However, men and women are known to have different vulnerabilities to the effects of EDS. For women, these may be related to a higher proportion of fatty tissue, and to hormone-regulated cycles and processes of menstruation, pregnancy and menopause. In men, EDS exposure may contribute to “male reproductive syndrome,” as manifested in lower sperm counts, reproductive birth anomalies and testicular cancer.¹⁸ It appears likely that such clinical outcomes are due to events occurring very early in development.^{19,20}

The Senior Years

Over the past century, medical science has made it possible for people to live much longer. Ironically, longer life also means greater exposure to the harmful effects of the environment. As a result, seniors face

particular health risks, not only due to the cumulative effect of environmental hazards, but also to the declining “margin of safety” in key organ systems such as the cardiorespiratory and immune systems, and to the presence of pre-existing health conditions.

The effects of this combination of age and disease-related risks are particularly evident in seniors’ greater susceptibility to air pollution. Aging commonly reduces a person’s “maximum oxygen uptake,” with the result that seniors can find it difficult to meet their daily oxygen requirements.²¹

In such cases, even low levels of pollutants can have a critical effect. Research also shows that the prevalence of chronic obstructive pulmonary disease (COPD) increases with age;²² lungs and airways that are compromised by COPD are more susceptible to the effects of both indoor and outdoor air pollution. 🌐

Over the past century, medical science has made it possible for people to live much longer. Paradoxically, longer life also means greater exposure to the harmful effects of the environment.

A special thanks to the following people for their input into this article: Sari Tudiver and Monica Mavrak, Women’s Health Bureau, Health Policy and Communications Branch; Louise Plouffe, Tye Arbuckle and Barbara Sérandour, Centre for Healthy Human Development, Population and Public Health Branch; and Priya Raju, Safe Environments Programme, Healthy Environments and Consumer Safety Branch, Health Canada

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Shigellosis

and First Nations Communities

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Low rates of diarrheal diseases in developed nations such as Canada reflect enormous improvements in hygiene and infrastructure during the past century. Despite this progress, the recent *Escherichia coli* outbreak in Walkerton is a reminder that some communities are still vulnerable to diarrheal diseases linked to the environment. A large outbreak of the diarrheal disease shigellosis also occurred recently in Ottawa, due to a contaminated food source. Although shigellosis outbreaks of this magnitude are not common in most Canadian communities, many First Nations communities experience a disproportionate burden of this disease as a result of a range of environmental conditions.

What is Shigellosis?

While cardiovascular disease and cancer may strike fear in the hearts of many Canadians, most people probably don't know anything about a potentially fatal disease called shigellosis. Shigellosis is an acute, bacterial disease characterized by diarrhea, fever and nausea. People may become infected by ingesting food or water contaminated with **shigella** bacteria, or through fecal-oral, person-to-person spread. The disease has an incubation period of one to three days and lasts an average of four to seven days. Treatment in Canada usually includes oral rehydration salts and sometimes antimicrobial medications. Thus, case fatality in Canada is fortunately quite low.

Diarrheal diseases are the second leading cause of mortality worldwide among children less than 5 years of age. *Shigella* is one of five organisms that cause the majority of pediatric diarrhea cases in almost all geographic regions. It is the most significant cause of bloody diarrhea in the world and is responsible for nearly all episodes that are clinically severe or fatal.¹

Shigellosis in Canada

All provinces and territories have legislation in place to ensure that cases of shigellosis are reported to public health authorities. In 1999, the reported incidence rate of shigellosis in Canada was 3.6 per 100,000 people. Children aged 5-9 years experienced the highest rate of any age group, at 14.5 per 100,000. Overall rates were higher in the Prairie provinces than in other parts of Canada, with the highest rates in Manitoba (14.0 per 100,000).²

About the Data

Working in partnership with First Nations and provincial health authorities, the First Nations and Inuit Health Branch (FNIHB) of Health Canada provides primary health services and public health programs in First Nations communities. Cases of shigellosis and other notifiable diseases occurring in First Nations communities are reported to FNIHB regional offices. Notifiable disease data for 1999 were compiled at the national level, analyzed and compared to 1999 data for

the entire Canadian population. As well, trend data of reported cases in three regions and hospital separation data in two regions were obtained from FNIHB regional offices and computerized hospital discharge files, respectively.

A Disproportionate Burden

The First Nations on-reserve population for which shigellosis cases were reported represents 1.1 percent of the Canadian population. However, 23 percent of all reported shigellosis cases and 47 percent of cases among children aged 0-14 years occurred in the First Nations on-reserve population in 1999. The reported incidence rate of 74.1 per 100,000 among First Nations communities for that year was 26 times higher than the non-First Nations rate of 2.8 per 100,000.

The vast majority of First Nations cases (93.6 percent) in 1999 were reported in Alberta, Saskatchewan and Manitoba. Reported incidence rates were consistently higher among First Nations communities than in the non-First Nations populations of these provinces during the late 1990s (see Figure 1). Hospital separation rates for shigellosis were also higher among First Nations in Saskatchewan and Manitoba throughout the decade. Over 80 percent of First Nations shigellosis patients hospitalized in the two provinces during that period were children aged 0-14

years. An epidemic in Manitoba during the early 1990s affected *more than half* of the First Nations communities in that province.

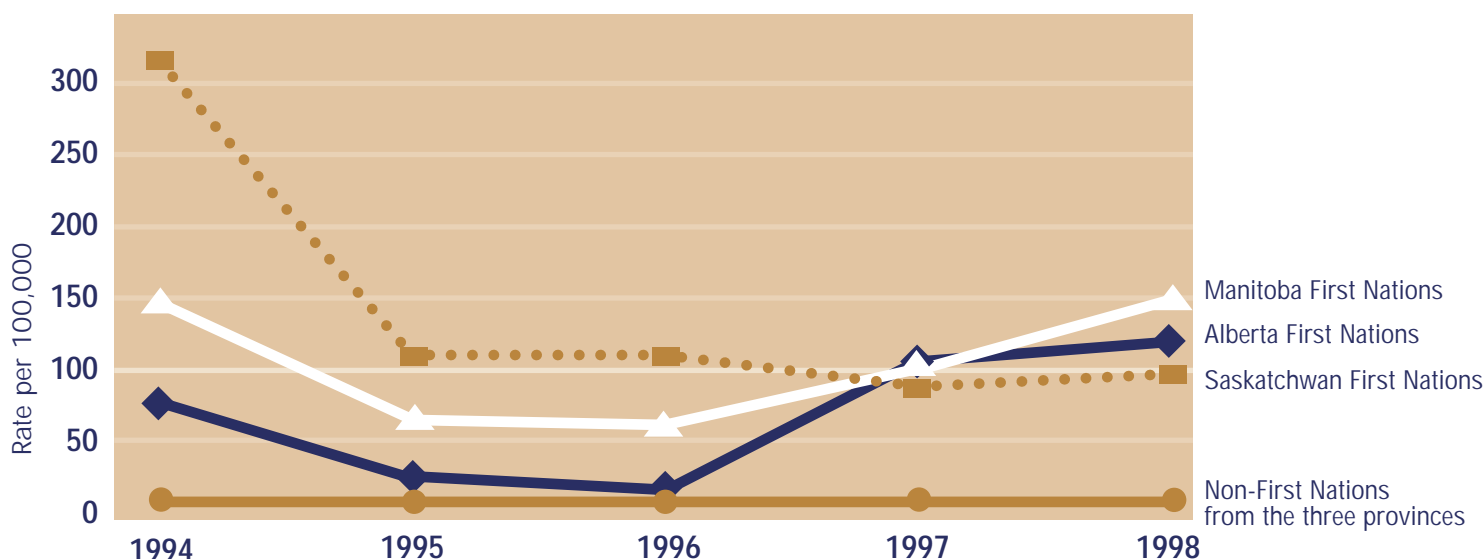
Most Canadians escape shigella infection during childhood, while those who do become infected are generally exposed as a result of travel in high-risk countries or during common-source outbreaks, such as the recent food-borne outbreak in Ottawa. In developing nations, where epidemics of shigellosis are common, the majority of morbidity and mortality occurs among children. Notably, the age distribution of shigellosis cases in the Canadian First Nations population is very similar to what is generally observed in developing countries.

Figure 2 shows 1999 age-specific incidence rates in the First Nations and non-First Nations populations at the national level. The highest rate was reported among First Nations children aged 1-4 years (250 per 100,000). Eighty-six percent of First Nations cases in 1999 occurred among children aged 0-14 years, while 30 percent of non-First Nations cases were reported in this age group.

Environmental Links

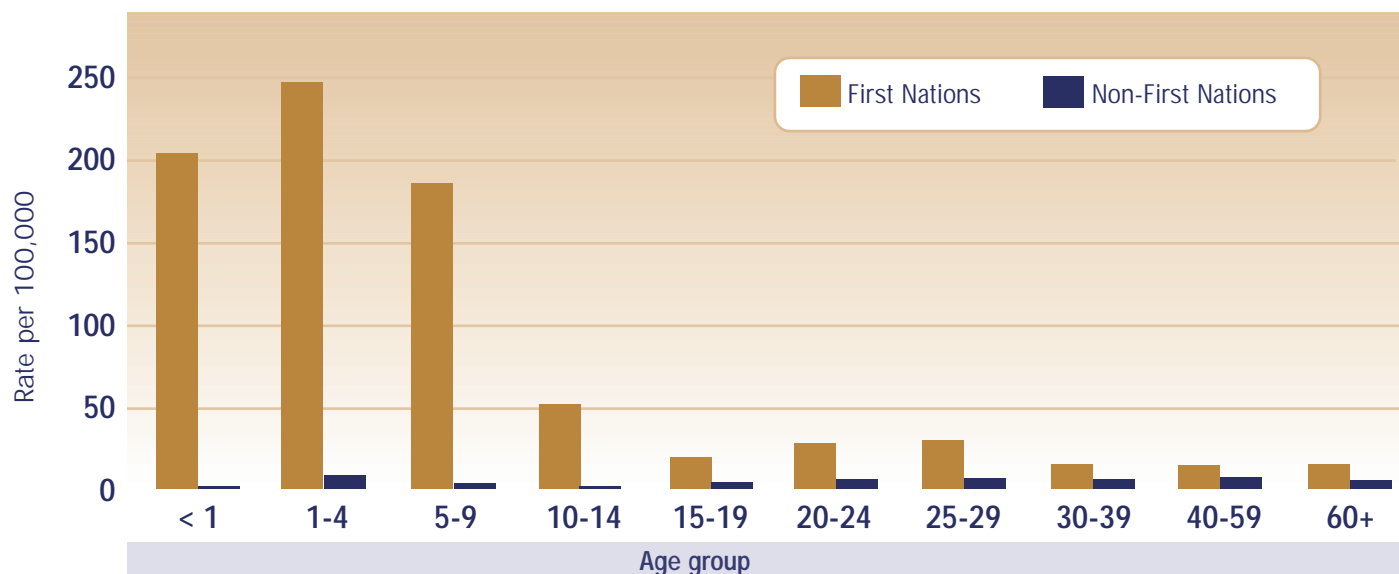
Researchers have identified important links between shigellosis and a number of factors in the environment, including sewage disposal methods, water supply systems and housing conditions.

Figure 1: Comparison of Reported Shigellosis Incidence Rates in the First Nations and Non-First Nations Populations of Three Provinces, 1994-98



*Note: Data points represent three-year moving incidence densities (years represent mid-year of three-year periods).

Figure 2: **Age-Specific Shigellosis Incidence Rates in the Canadian First Nations and Non-First Nations Populations, 1999**



Sewage Disposal

Humans are the only significant reservoir of shigella bacteria. To be a source of infection, water and food must be contaminated with human feces containing shigella. As a result, communities with inadequate systems for sewage disposal are at increased risk for shigellosis. People living in households lacking sewage removal systems must sometimes use indoor pails for toilets. Children may then be exposed to infection if feces and diapers are disposed of in the yard. Communities with home sewage systems may also be at risk for shigellosis if sewage disposal systems are improperly constructed. Shigellosis cases have been linked to sewage backing out through basement drains and poorly constructed surface disposal systems. Families using wells may also be at risk if septic systems are located near the well or well water source.

In many cases, sewage systems in First Nations communities do not meet provincial design and installation standards. The proportion of First Nations households with adequate sewage disposal increased from 79 percent in 1990 to 94 percent in 2000.³ While this is a significant improvement, many people in areas where shigella is endemic still do not have access to adequate sewage disposal. In 1999, 22 percent of housing units in First Nations communities in Manitoba lacked modern plumbing (an indoor toilet and an assured supply of running water).⁴

Water Supply

Following the recent *E. coli* outbreak in Walkerton, concerns regarding the *quality* of available drinking water have been raised throughout the country. While the importance of ensuring a safe supply of drinking water should not be underestimated, research has shown that simple access to enough water for daily washing with soap (*water quantity*) is a far greater determinant of childhood diarrheal disease than water quality.¹ Access to a sufficient water supply for basic hygiene is a problem in many First Nations communities — a concern one might expect to find in developing countries but not in Canada.

In communities lacking a water delivery system, families must fill drums from a standpipe or at lakes and rivers. Others may have water delivered by truck to barrels in their houses or to household cisterns. These methods of water supply limit the amount of water available for hand washing, which can increase the risk of fecal-oral person-to-person spread of shigella bacteria. A study of Manitoba First Nations communities found that shigellosis rates were six times higher in communities with truck-to-barrel water delivery than in communities with piped systems. The association between the type of water delivery and the incidence of shigellosis remained significant in a multivariate analysis of risk factors.⁵

Crowded Housing

Overcrowded housing conditions increase the contact rate between individuals and the risk of person-to-person spread of many communicable diseases. Shigellosis is the most communicable of the bacterial diarrheas. Only 10 to 100 viable organisms must be ingested for the disease to occur in an individual.⁶ Forty percent of people who are exposed to a case of shigellosis may be infected through person-to-person transmission and attack rates may be much higher among children.⁷ Shigellosis rates in the Manitoba First Nations population have been shown to increase with rising household densities.⁵ Overcrowded living conditions is a problem in many First Nations communities — the average housing density among First Nations on-reserve dwellings is 0.7 persons per room, compared to the Canadian average of 0.4 persons per room.

Combatting Shigellosis

The high rates of shigellosis among First Nations people and the impact of this disease on children's health are unacceptable. Short- and long-term strategies must be implemented to combat shigellosis and its environmental determinants.

Short-Term Prevention

In communities at high risk for shigellosis outbreaks, health promotion can play an important short-term prevention role. Health promotion messages should promote careful hand washing with soap and water, proper food handling practices, breastfeeding of infants and boiling water for infant formula. Children with shigellosis should be excluded from daycare centres until their stool samples test negative for the bacteria. Emphasizing good personal hygiene and sanitary food preparation techniques is particularly important for those preparing food for large cultural events, such as pow wows. Parents living in communities with inadequate sewage disposal systems should be educated to dispose of feces and diapers away from areas frequented by children. Health promotion and education initiatives can be carried out in community meetings, workshops and radio programs and by distributing pamphlets in First Nations communities.

It is also important to carry out inspections of public facilities, such as daycare centres and long-term care facilities, to identify factors that may lead to disease. Environmental assessments of water supply and sewage

systems can identify problems of contamination. These functions are mainly the responsibility of public health authorities in First Nations communities, such as FNIHB and First Nations transferred health authorities. Medical officers of health, environmental health officers, community health nurses and community stakeholders are all important in conducting assessments and implementing effective corrective action. Early detection of shigellosis cases and rapid intervention recently prevented a large outbreak in one Alberta First Nations community.

Long-Term Prevention

Long-term strategies include those directed at combating the environmental determinants of shigellosis. Measures that will contribute to a long-term reduction in disease burden are described briefly below.

Measures for the Long-Term Prevention of Shigellosis in a Community

- ▶ ensure that the water supply is adequate for daily washing with soap
- ▶ provide sewage disposal and treatment systems
- ▶ ensure houses and sewage systems meet appropriate standards for design and installation
- ▶ build septic systems at an adequate distance and downhill from wells and well water sources
- ▶ introduce measures to limit overcrowded living conditions

Unfortunately, these solutions are beyond the control of public health authorities, although they must advocate for changes when links between environment and disease are found. Responsibility for finding long-term solutions is shared among the Department of Indian and Northern Affairs (INAC), First Nations

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Sulphur

in Gasoline and Other Fuels: The Case for Action (and Inaction)

Due to concerns about the contribution of vehicles to poor air quality, the Canadian government, in conjunction with the petroleum industry, motor vehicle manufacturers, provincial governments and public interest groups, undertook a detailed analysis of the impact of sulphur levels in gasoline on air quality and health, and the implications for Canada's fuel industry. Up until the late 1990s, sulphur levels in gasoline were not regulated and, as a result, varied widely across the country according to crude oil quality and refinery capabilities. Sulphur in gasoline contributes directly to tailpipe emissions and atmospheric pollution but, more importantly, poisons catalytic converters. Catalytic converters are installed on all modern automobiles and reduce a wide range of gasoline combustion products that are toxic and contribute significantly to smog. The authors explore how the evidence that emerged from this multi-stakeholder process provided the basis for legislation regulating the sulphur levels in gasoline.

A Three-Part Process

Generally speaking, air quality mitigation strategies use a variety of tools to predict the potential for such strategies to deliver air quality improvements and associated health benefits (see Figure 1).

The sulphur in gasoline review, the most detailed of these efforts conducted to date, was designed in three stages — process design, fact finding, and the development of options and recommendations. In the first stage, government and industry representatives developed an overall plan for the process, while in the second stage, three expert panels gathered evidence in the following issue areas — atmospheric modelling,¹ health and environmental impacts,² and industry cost and competitiveness.^{3,4} In the third stage, government regulators built on the results of the fact-finding stage to develop regulations for sulphur levels in gasoline for Canada.

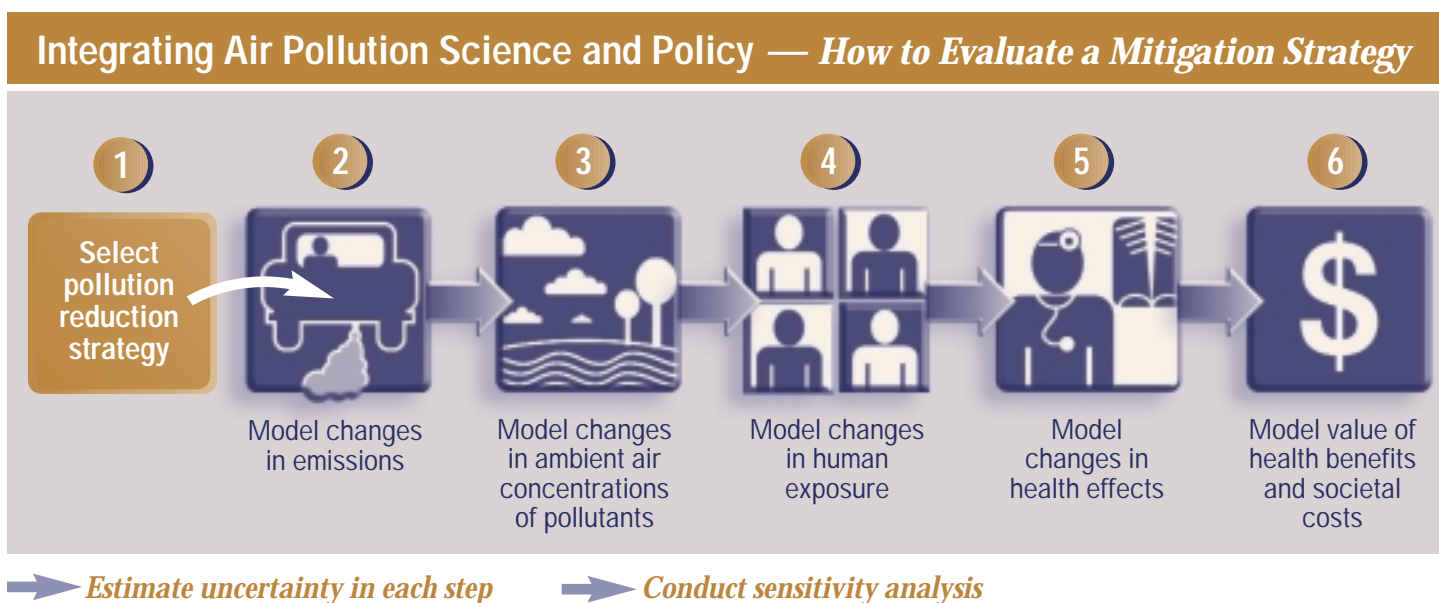
Building the Evidence

It is widely recognized that sulphur is a poison for many chemical and catalytic processes. Evidence indicates that sulphur at levels present in Canadian gasoline prior to regulation significantly reduces the capability of the automotive catalytic converter. As a result, cars emit much more sulphur dioxide, particulate matter, nitrogen dioxide, sulphates and other smog-forming pollutants than they would using gasoline with lower sulphur levels. The sulphur-in-gasoline process used this knowledge as its starting point for determining the implications of establishing a regulation concerning sulphur levels in gasoline.

The fact-finding stage of the process focussed on a number of scenarios, including six potential regulation levels for sulphur in gasoline, ranging from 350 to 30 parts per million (ppm). The expert panel on atmospheric modelling used the scenarios to project changes in tailpipe emissions and the resultant effects on air quality. The panel on health and environment, in turn, used these projected changes to estimate impacts on human and environmental health.

While the most significant changes in air quality were projected for sulphur dioxide and sulphate, significant reductions were also

Figure 1: General Process Chart for Conducting Air Quality Benefits Analysis



predicted in several other pollutants, including carbon monoxide, nitrogen oxides, volatile organic compounds and, to a small extent, ozone. The primary source of data was epidemiological literature focussing on sulphate as the primary pollutant and providing quantitative estimates of its effects. A key element in the expert panels' deliberations was the presumption that the sulphate signal captured in the published literature was indicative of the type of emissions being reduced, rather than being the causative agent. In fact, panel members acknowledged the possibility that using this approach would underestimate the true benefits of reducing sulphur levels in gasoline, since this literature would only partially capture the effects of the reduction of the other pollutants (i.e., the "soup" of chemicals to which people are exposed and which cause effects).

At the same time, however, they felt that this literature provided the most credible approach, as it contained sufficient material to provide some estimate of the health effects that would be avoided due to reductions, including premature mortality, chronic respiratory disease, cardiac and respiratory hospitalization, emergency room visits, asthma symptoms, restricted activity, and acute respiratory symptoms and lower respiratory illness in children.

As part of the fact-finding phase, a monetary valuation of the avoided effects was conducted, based on health economics literature. The panels also calculated

the actual costs of retrofitting refineries to meet the various proposed sulphur standards, as well as the projected impact of these standards on the competitiveness of the industry both within Canada and abroad.

For the most stringent option considered (i.e., 30 ppm, the current standard in California), it was determined that the cumulative health impacts *avoided* over a 20-year period would include: 11 million new cases of croup and pneumonia; five million days of asthma or other restricting illnesses; 100,000 new cases of child and adult chronic bronchitis; 9,000 emergency or hospital admissions; and over 2,000 cases of premature mortality. While this option reduced only a small percentage of total mortality (annual mortality in Canada is approximately 240,000), hospital admissions, emergency room visits, chronic bronchitis and other endpoints, it appeared to be a cost-effective measure. The associated economic value of avoiding these health effects (based primarily on monetary values associated with premature mortality and illness costs) was estimated to be greater than \$6 billion over 20 years. The costs to industry for complying with the proposed standards (based on new capital costs and ongoing operating costs) were estimated to be under \$3 billion over 20 years. It is important to note that, because of data limitations, health benefits could only be calculated for the seven largest Canadian cities (representing about 40 percent of the national population), while

refinery costs were calculated for the entire Canadian industry. For this reason, the expert health panel characterized the benefits as an underestimate of the true total.

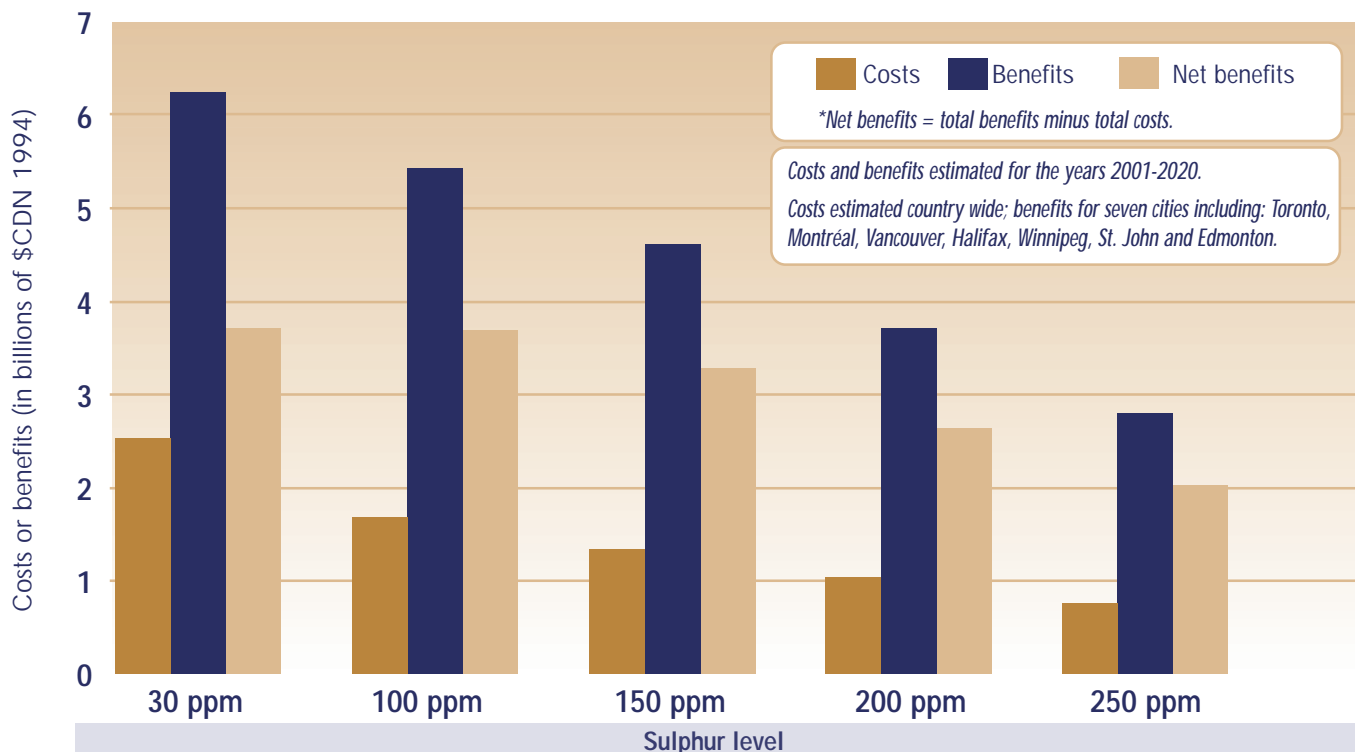
Regulating Action

Based on these findings, the Government of Canada chose the most stringent standard of 30 ppm. Of the six options studied, this standard resulted in the greatest difference between benefits and costs (see Figure 2). It is interesting to note that, while the health benefits were directly proportional to sulphur reductions, the costs to industry were not. Small reductions in sulphur could be gained by relatively minor interventions in most refineries, while more ambitious targets (approximately 150 ppm) required significant investment to install complex technologies. Having installed these technologies, further reductions in sulphur levels do not require additional expensive technology, only increased operating costs. As a result, costs were not linear with reducing sulphur levels and, combined with other (often refinery-specific) factors, resulted in the most stringent level providing the greatest net benefits. Factors that played a key role in the decision included the effects on catalytic converters, the direct health benefits and reasonable costs.

The new regulation, as embodied in the *Canadian Environmental Protection Act (CEPA)*, requires a phase-in period with a 150 ppm (average) standard that started in July 2002, with the 30 ppm standard to be achieved by January 2005. This regulation will bring Canadian sulphur levels into line with current Japanese and California standards, as well as with proposed US and European standards.

In the process leading up to the regulation's development, the industry indicated that up to six of the eighteen existing Canadian refineries might have to close, and that supply shortages and significant price hikes in southern Ontario would result if the 30 ppm option was chosen. After the regulation was passed, the industry lobbied strongly for an amendment that would allow individual refining companies to eliminate the phase-in period beginning in 2002 and move forward the date of the 30 ppm requirement by one year. After detailed refinery-by-refinery analysis, the government concluded that this strategy would result in fewer health benefits than the existing regulation because moving forward the 30 ppm date by one year would not fully compensate for eliminating the phase-in period. Based on this further scientific analysis, the government declined to amend the regulation. The industry has since indicated that they

Figure 2: **Costs and Benefits of Sulphur-Reduced Gasoline (in terms of net present value; year 2000)**



do not expect to close any refineries and that there are no technological or economic constraints in meeting the regulation.

Lessons Learned: Moving Forward

As part of ongoing efforts to reduce the impacts of fossil fuel combustion (e.g., home heating oil, diesel, heavy fuel oil), the federal government is considering a series of sulphur-related measures. However, it is important to note that the experts involved in the sulphur in gasoline panel were greatly persuaded by the multi-pollutant reductions afforded by reducing sulphur, which allowed the automotive catalytic converter to perform at its design level. This is a key consideration in attempting to extrapolate the sulphur in gasoline results (even qualitatively) to other situations. For example, Canada has announced a regulation that will require greatly reduced emissions from diesel engines and require very low sulphur levels in diesel. This regulation will require the installation of catalytic converters and particle traps (both of which require very low sulphur fuel). As was the case with gasoline, the significant sulphur reductions will enable technologies that reduce a number of pollutants (nitrogen oxides, particles, etc.). While the spectrum of pollutants is quite different and the direct application of the sulphur in gasoline results might be questioned, there is nonetheless a compelling case for introducing the regulation and the promise of health benefits as a result of doing so.

However, when the discussion moves to other fuels, such as light fuel oil (LFO), heavy fuel oil (HFO) and even coal, the supposition that reducing sulphur will result in health benefits is questionable. Currently, there is a movement to implement regulations that will reduce sulphur levels in LFO and HFO on the expectation of health benefits. However, since a technological aspect (i.e., catalytic converters or particle traps) is not included, the reductions in emissions will be confined to sulphur dioxide and sulphate, with no expectation of reductions in nitrogen oxides, carbon monoxide,

ozone or volatile organic compounds. This factor limits the applicability of the logic and rationale developed and followed by the sulphur in gasoline study described above.

On the other hand, sulphate is a particle, a fact that would appear to provide a justification for these measures as particulate matter (PM) has been declared toxic under the CEPA. However, the strategy comes into question when one considers the basis for labeling PM as toxic. The evidence is almost exclusively based on large-scale epidemiological studies (the same type of study used by the health effects panel), which have found a significant and consistent association between ambient PM and mortality. The consistency of the findings from these studies has convinced health and environmental agencies (including Health Canada, the US Environmental Protection Agency and the WHO) to support actions to reduce PM in general.

It must be noted, however, that the PM referred to in the above studies is a chemically complex mixture and part of a “soup” of other air pollutants (e.g., carbon monoxide, nitrogen dioxide, ozone, etc.). When a risk management strategy reduces many of these constituents, there is a reasonable level of confidence that the causative agents are being addressed. Where one specific component is selectively reduced, there is less confidence of a benefit.

To summarize, sulphur reductions will enable technology that reduces a spectrum of air pollutants in the case of gasoline and diesel. For other sulphur reduction strategies, only one or, at best, two pollutants will be reduced. Current PM research is focused on finding the factors that give PM its toxicity. Such research, given time, will give much greater focus to risk management strategies and potentially deliver much greater health benefits for the money spent. Extrapolating the results of the sulphur in

gasoline analysis beyond a reasonable degree may lead to misdirection of risk management resources and the development of a potentially false sense of progress in combatting the population health impacts of poor air quality. 🌐

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Canada has announced a regulation that will require greatly reduced emissions from diesel engines and require very low sulphur levels in diesel.

Who's Doing What?

Who's Doing What? is a regular column of the Health Policy Research Bulletin that looks at key players involved in generating policy research within a specific theme area. Because the theme of "Health and the Environment: Critical Pathways" covers such a broad spectrum, the current column focuses on stakeholders active in the specific policy research areas addressed in this issue of the Bulletin.

National Environment and Health Research Agenda

The Canadian Institutes of Health Research (CIHR) are collaborating with Health Canada, Environment Canada and other stakeholders to set a national research agenda on environmental influences on health. The agenda aims to strengthen research, guide funding decisions, and encourage the development of multi-disciplinary, multi-sectoral research projects and innovative funding partnerships. CIHR developed a draft discussion paper for a national conference held on September 13-14, 2002 (available at: http://www.cihr-irsc.gc.ca/institutes/ihdcyh/index_e.shtml).

Surveillance and Indicators

A number of organizations report on various aspects of the health-environment relationship:

- In March 2002, the Environics Research Group conducted a poll for Health Canada entitled "Air Pollution and Its Impact on Health" with Canadian health care professionals. The study addressed topics such as perceived effects of air pollution on health and perceived seriousness of air-related health problems in comparison to other health problems. For more information, E-mail dddd_arad-draa_dedd@hc-sc.gc.ca
- The World Health Organization (WHO) publishes various reports on environment and health, such as *Environmental Health Indicators: Framework and Methodology* (available at: http://www.who.int/environmental_information/Information_resources/on_line_documents.htm).



- The Health Effects Institute (HEI) is an independent, non-profit corporation that aims to provide high quality, impartial and relevant research on the health effects of pollutants from motor vehicles and other sources in the environment. A collaborative initiative of the US Environmental Protection Agency and industry, HEI has published over 100 research reports (available at: <http://www.healtheffects.org>).
- The Health and Environment Group of the Centre hospitalier universitaire de Québec (CHUQ) brings together professionals and researchers from many disciplines to research topics related to health and the environment. For more information about CHUQ, see: <http://www.chuq.qc.ca/oms/en/mission/mission.htm>
- The International Joint Commission (Canada/USA) held a Conference on Environmental Health Surveillance in Québec City in October 2000. Conference papers focussing on developing environmental health indicators are available at: <http://ottserver1.ottawa.ijc.org/hptf>
- The goals of the Environmental and Occupational Health Surveillance Working Group are to: identify relevant surveillance networks and systems in Canada; assess needs and opportunities to strengthen capacities; and recommend initiatives and priorities for Canada. The Working Group reports to the Federal/Provincial/Territorial Committee on Environmental and Occupational Health, while Health Canada's Healthy Environments and Consumer Safety Branch (HECSB) coordinates the Working Group's efforts in collaboration with its partners. For more information, E-mail Sheryl_Bartlett@hc-sc.gc.ca

Women, Health and Environments

The Centres of Excellence for Women's Health Program, which is funded by Health Canada's Women's Health Bureau, has released a number of research papers on the subject of women, health and environments (available at: <http://www.cewh-cesf.ca/>).

Children's Environmental Health (CEH)

The effect of the environment on children's health has been the subject of several recent workshops and other initiatives of note:

- In May of 2000, the Five Natural Resources Working Group on CEH, established by Health Canada, organized a national workshop to identify priorities and opportunities for interdepartmental collaboration. A report on the workshop is available at: <http://www.durable.gc.ca>
- Health Canada and Environment Canada cohosted the Canadian CEH Research Workshop in Ottawa in March 2002. Among other objectives, the workshop aimed to develop a Canadian CEH research agenda. The program is available at: http://www.hc-sc.gc.ca/pphb-dgspsp/cehs-esm/wkshop_e.html
- The Commission for Environmental Cooperation (CEC, Mexico/USA/Canada), the International Joint Commission and the Pan American Health Organization are currently preparing a joint project on measuring children's environmental health. The project is part of the CEC Cooperative Agenda for Children's Health and the Environment in North America (see: <http://www.cec.org>).
- In 2001, the Canadian Institute of Child Health and the US Children's Environmental Health Network cohosted a Global Forum on CEH. The resulting *Joint Declaration on Children's Environmental Health* outlined significant threats to the health of the world's children and identified areas in which immediate action was needed (available at: <http://www.cich.ca/postglobal.htm>).

Food and Water Safety

A number of important initiatives are under way to address issues related to food and water safety:

- Health Canada's Healthy Environments and Consumer Safety Branch (HECSB) recently collaborated with Environment Canada and several other partners to deliver an international conference on water safety in

Ottawa on September 23-25, 2002. The objective of the conference, entitled *Drinking Water Safety: A Total Quality Management Approach*, was to provide a forum for innovative approaches to such issues as ecosystems and health indicators of water quality and science and policy guidelines for drinking water safety (available at: <http://www.neram.ca/Pages/events/events.htm>).

- The Institute of Infection and Immunity of the Canadian Institutes of Health Research (CIHR) is taking the lead in establishing the Canadian Coalition for Safe Food and Water. Designed to promote a coordinated approach to research funding in this area, the Coalition comprises 17 partners, including federal government departments and agencies, as well as industry and professional bodies. For more information, E-mail Kim_Elmslie@hc-sc.gc.ca or jbray@cihr.ca
- The Toxic Substances Research Initiative (TSRI) is a \$40 million program that is managed by Health Canada and Environment Canada. Launched in 1998, TSRI's primary goal is to increase the level of knowledge about toxic substances and their adverse effects. Research synopses are available at: <http://www.hc-sc.gc.ca/tsri>



The objective of the conference, entitled *Drinking Water Safety: A Total Quality Management Approach*, was to provide a forum for innovative approaches to such issues as ecosystems and health indicators of water quality, and science and policy guidelines for drinking water safety.

Health Impact Assessment

Health Canada has developed a draft *Canadian Handbook on Health Impact Assessment (HIA)* promoting the integration of HIA into environmental impact assessment (EIA). According to the Handbook, including the key determinants of health in an EIA framework is a cost-effective method for integrating the health effects of development projects, programs and policies into the decision-making process. The Handbook's three volumes are targeted at health professionals, environmental assessment practitioners and the public (available at: <http://www.hc-sc.gc.ca/oeha>). 🌐

Using Canada's Health Data is a regular column of the Health Policy Research Bulletin highlighting some of the methodologies commonly used in analyzing health data. This issue examines the role of health surveillance and discusses how surveillance data are created, analyzed and used.

Surveillance: What Is It?

Elizabeth Stratton, Centre for Surveillance Coordination, Population and Public Health Branch, Health Canada, and **Pierre Gosselin**, Institut national de santé publique du Québec

Health surveillance is the ongoing, systematic use of routinely collected health data to guide public health action in a timely fashion.¹ Surveillance processes include the collection of data, the integration, analysis and interpretation of that data into surveillance products, and the dissemination of the surveillance products to those who need to know. Surveillance has the following key attributes: it generally involves the collection of data in a continuous fashion; it is population based; and it produces information and analytical products.

An essential component of both these definitions is the notion of ongoing data collection of either new or existing data. New data are collected prospectively for the purpose of surveillance, such as with surveys that focus on specific conditions and/or risk behaviours. For instance, Health Canada's Canadian Tobacco Use Monitoring Survey (CTUMS) generates new data on smoking behaviours in regular cycles. New data are also collected on nationally notifiable diseases (conditions where there are legislated mandates for reporting — from a local public health region to the province or territory). A number of communicable diseases are nationally notifiable by virtue of their potential for serious population health consequences (e.g., measles,

meningococcal infections and sexually-transmitted diseases). Data are immediately recorded for these conditions as a part of routine public health disease prevention and control practice.

Existing data are retrieved for surveillance from a variety of available sources. Examples include surveys and databases established for purposes other than surveillance, such as hospital-based administrative databases, disease registries and vital statistics. Chronic disease surveillance relies heavily on existing data sources. The National Diabetes Surveillance System, for example, uses administrative data originating in provincial/territorial jurisdictions to provide national level surveillance information on diabetes (http://www.diabetes.ca/Section_Professionals/index.asp).

Surveillance does not stop at data collection. Regardless of whether new or existing sources are used, the data are then analyzed and transformed into measures describing population health. For example, how much disease is in the population (prevalence); how much newly-occurring disease is in the population (incidence); and, for some diseases, what proportion of the population has received an immunization against the disease (coverage rate).

Surveillance provides the means to monitor health and environmental outcomes. By monitoring and comparing disease occurrence and environmental risk over time, the impact of exposures and interventions can be measured.

How Are Surveillance Data Used?

To be useful in protecting health, surveillance data must be collected frequently, with rapid turnaround from raw data to analyzed surveillance information indicating unusual or unexplained occurrence or pattern of illness. Outbreaks of food-borne illness, for example, need to be detected and reported quickly so that control measures can be put into place. As such outbreaks can occur within hours of exposure, the system must have “real time” detection capabilities. Clusters of events in time are not the only indicators of health problems — surveillance must also be capable of detecting rare and unusual events where

Surveillance Information Products

Health Canada produces and distributes a variety of timely surveillance information:

- Disease Surveillance Online (<http://www.hc-sc.gc.ca/pphb-dgspsp/dsol-smed/>) provides information on notifiable diseases and chronic diseases.
- *Infectious Diseases News Brief* (<http://www.hc-sc.gc.ca/pphb-dgspsp/bid-bmi/dsd-dsm/nb-ab/index.html>) provides national and international information (provisional and confirmed) about communicable disease incidents and issues.
- Two periodicals that are also available online are *Canada Communicable Disease Report* (<http://www.hc-sc.gc.ca/pphb-dgspsp/publicat/ccdr-rmtc/>) and *Chronic Disease in Canada* (<http://www.hc-sc.gc.ca/pphb-dgspsp/publicat/cdic-mcc/index.html>).

there may be only one or two cases. Such cases may not be close in either space or time, but may indicate emerging problems. An example is the detection of extremely rare cancers associated with occupational exposures.

As previously noted, Health Canada receives information on a series of notifiable diseases. Surveillance for these diseases is conducted at the local, regional and provincial/territorial levels, with case level reporting by condition, location, time, gender and age group only at the national level — individuals cannot be identified.

The urgency and completeness of reporting also vary depending on the specific condition. Measles is an example of surveillance where each case must be reported to local public health offices as close to “real time” as possible, to permit effective public health follow-up on each case. For many other diseases, the aim of surveillance is to detect and respond to trends in disease activity. Influenza, for example, is consistently under-reported; it is neither practical nor necessary to count each case in order to obtain a trend for influenza activity in the population. 🌐

@ [Click here for references.](#)

Shigellosis, continued from page 18 ►

community leaders and the FNIHB. It is not likely that a single environmental intervention will be adequate to rid First Nations communities of shigellosis or developing countries of common diarrheal diseases. Sufficient access to water, adequate sewage disposal systems, reductions in crowded living conditions and good personal hygiene are all needed to prevent shigellosis.⁸ These actions will also help to prevent other infectious diseases with similar socioeconomic and environmental determinants, such as hepatitis A and tuberculosis.

It is important to emphasize that not all First Nations communities experience a disproportionate burden of shigellosis. The epidemiology of the disease

varies dramatically between regions and improved sanitation has made a significant difference in many communities where shigellosis was once common. Preventive programs must be maintained and intensified in communities where shigellosis cases continue to be reported. 🌐

The author would like to thank the FNIHB Health Data Technical Working Group, Marion Perrin and Wadieh Yacoub of Alberta Region, and Suzanne Martel of Manitoba Region for providing shigellosis data and outbreak reports. The author would also like to acknowledge Saskatchewan Health and Manitoba Health for contributing hospitalization data.

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Did You Know? is a regular column of the Health Policy Research Bulletin examining aspects of health research and data that may be subject to misconceptions. In this issue, we examine some of the considerations that should be taken into account when interpreting whether or not research results are statistically significant.

A Journey into Statistical Significance

Martin Ducharme, Applied Research and Analysis Directorate, Information, Analysis and Connectivity Branch, Health Canada

Consider the following scenario: a team of researchers is studying the discharge of pollutants into water by a particular industry to determine whether a new technology is cleaner and thus better for the environment than the system currently in use. They know that the average concentration of a toxin observed in water surrounding a sample of facilities using the current system is 4.0 mg/l. For a sample of facilities using the new technology, the average concentration of the same toxin in surrounding waters is 3.2 mg/l. *Should they conclude that the new system is better for the environment? Should they recommend that this new technology be used in the facilities still using the standard system?*

Answering these questions may not be as simple as it appears. This column explores the concept of statistical significance and explains its most important elements. The discussion is intended to provide readers with a better understanding of some of the statistical terminology they may encounter while reading research reports.

Statistical Inference, Hypothesis Testing, P Values ... What Do They Mean?

For many people, the notion of statistics is limited to averages or the numbers used to describe how well their favourite teams or players are faring. In fact, these are part of a field called **descriptive statistics** — numbers that deal with the presentation, organization, summarization and, hence, the description of data.

The statistics examined in this column are quite different. Because studies can consume considerable time and resources, researchers must invariably limit their investigations to **samples** of the targeted populations. As a result, they are only able to produce estimates of the parameters for which they assume a true value exists. Any measurement based on a sample will differ from the true value by some amount as a result of random processes or chance. This is the main reason that the results of opinion polls are accompanied by phrases such as “with a three percentage point margin of error, 19 times out of 20.”

Therefore, analysts need tools to determine the likelihood that a conclusion drawn from a sample is true. This way of generalizing results from a sample to the entire population is called **inferential statistics**. Going back to the example described above, this means testing whether the lower measured concentration of the toxin is truly the result of a cleaner technology or whether it could be due to some random factor. Statistical significance is used to demonstrate that an effect did not occur by pure chance, but is more likely the result of a particular relationship between variables.

A bit like a criminal suspect who is considered innocent until proven guilty, the observed results of a study are first considered to be the same as what might have occurred as a result of chance alone.

Hypothesis Testing

A bit like a criminal suspect who is considered innocent until proven guilty, the observed results of a study are first considered to be the same as what might have occurred as a result of chance alone. This step is called the **null hypothesis** and it usually states that a variable has no effect on another, or that two or more variable distributions are no different from one another. The null hypothesis is always the most restrictive and its complement is called the **alternative hypothesis**. For the pollutant discharge example, the null hypothesis is that the toxin level is no different with the new technology than it is with the standard system (i.e., it is equal to 4.0 mg/l), while the alternative hypothesis is that the toxin concentration is different. ▶

P Values

The most common way to test if the null hypothesis holds true is to look at the probability of the observed outcome under that hypothesis. For the example above, this would mean looking at the probability of observing a concentration of 3.2 mg/l when the true concentration is really 4.0 mg/l. This probability is what is called the **P value** and it is formally defined as the probability of observing a test statistic as extreme as or more extreme than the one actually observed when the null hypothesis is true. The smaller the P value, the smaller the probability of the observed outcome under the null hypothesis.

The result is said to be statistically significant when one has sufficient confidence to rule out the possibility that it might have occurred according to the null hypothesis. The smaller the P value, the more confident one can be in ruling out the null hypothesis.

Analysts use threshold values to determine the statistical significance of a result. As an example, a result could be considered statistically significant when the probability of observing it under the null hypothesis is smaller than 5 percent (i.e., a P value of less than 0.05). The threshold value is called the **significance level** and it is often expressed as alpha (α). There are no rules of thumb in determining the significance level, but it is usually fixed at 1 percent, 5 percent or 10 percent.

A P value smaller than the determined significance level means that the observed event is sufficiently unlikely under the null hypothesis that the latter can be rejected and the result is said to be statistically significant. Although it is not explicitly stated, there is a tacit presumption that the alternative hypothesis provides a more reasonable explanation for that same event. A P value higher than the significance level means that the null hypothesis cannot be ruled out with confidence and the result is said to be non-statistically significant (note that one never accepts the null hypothesis, only rejects it or fails to reject it). In the current example, using a significance level

of 5 percent, one would need to find a P value smaller than 0.05 to reject the null hypothesis of no difference in the concentration level of the toxin.

Confidence Intervals

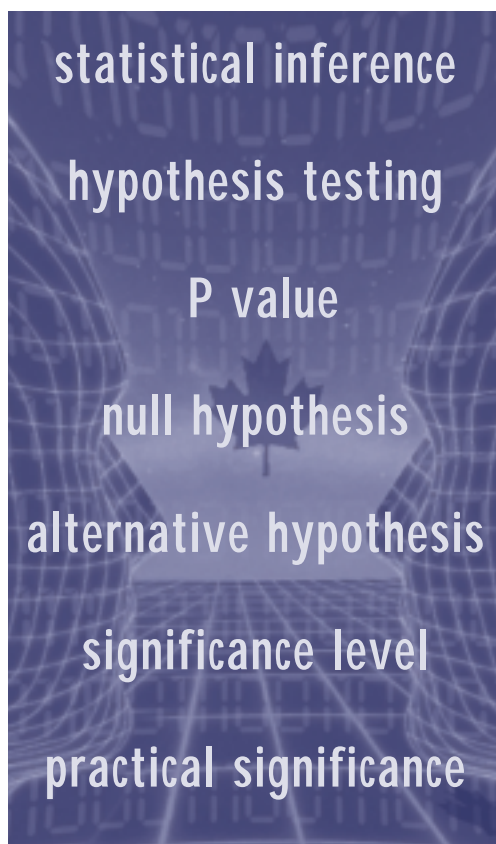
Finally, another way to see whether a result is significant or not is to build **confidence intervals** that would include 1-alpha percent (100 percent minus the significance level) of the observations. If the value of the null hypothesis remains outside the interval, the result is said to be statistically significant and the null hypothesis is rejected; otherwise, the result is non-statistically significant and one fails to reject the null hypothesis. For instance, if the 95 percent confidence intervals around the 3.2 mg/l measure exclude the value of 4.0 mg/l, the null hypothesis is rejected.

The Limits of P Values and Statistical Significance

The reporting of P values to determine the statistical significance of research results has become widespread because of their ease of use and the fact that most statistical software packages automatically produce P values for each estimated parameter. However, many articles published in educational or statistical journals have criticized the use of P values because they are often misinterpreted or misused.

One of the most widespread criticisms is that P values and statistical significance say nothing about the magnitude or the **practical significance** of the results. It is therefore possible for an effect of little practical importance to achieve a high degree of statistical significance, as it is possible for an important effect to be missed because a model lacks the statistical power to detect it at a given level of significance. However, statistical significance and practical significance should be viewed as complementary concepts rather than as competing ones. Since resources are limited, it's important to know about both the likelihood and the magnitude of the impact before investing in a new initiative. 🌐

@ [Click here for references.](#)



Test Your Knowledge

Suppose there are five new technologies reported to reduce the concentration of a specific toxin. The results of a study on the effects of these technologies are provided in the table below. Note that the measure reported is the observed reduction in the concentration compared to the standard system. Using a 5 percent significance level, try to determine which technologies have a statistically significant impact on the concentration of the toxin. Which ones have an impact of practical importance if it has been established that any reduction of less than 0.5 mg/l would not have a significant impact on the ecosystem and the health of the population? Should any of these technologies be recommended as a cleaner and healthier substitute to the standard system?

| Technologies | Observed reduction mg/l | P value | 95% confidence interval |
|--------------|-------------------------|----------|-------------------------|
| 1 | 0.1 | < 0.0001 | (0.08-0.12) |
| 2 | 1.8 | 0.0034 | (0.61-2.99) |
| 3 | 0.8 | 0.0010 | (0.40-1.20) |
| 4 | 0.1 | 0.5065 | (-0.20-0.40) |
| 5 | 1.8 | 0.2330 | (-1.18-4.78) |

Answers to “Test Your Knowledge”

- Technologies 1, 2 and 3 are statistically significant at the 5 percent level. The P values for these technologies are smaller than 0.05 and their 95 percent confidence intervals exclude the value of zero.
- With regard to confidence intervals, only the second procedure seems to be of any practical significance, while the results for the third and fifth procedures are unclear because their respective confidence intervals include values both above and below 0.5 mg/l.
- Only the second technology has both statistical and practical significance. This technology is therefore cleaner for the environment and healthier than the standard system currently in use. However, other studies might be required before this technology becomes the new standard. As an example, one might want to conduct a cost-benefit analysis to see whether the benefits of this new technology are worth its costs.



New and Noteworthy is a regular column of the Health Policy Research Bulletin highlighting “up and coming” policy research in the health field.

Health Canada Research Forum: From Science to Policy

On November 18-19, 2002, scientists and researchers from across Health Canada will come together in Ottawa to network and showcase their work and achievements. Sponsored by Health Canada’s Health Research Secretariat in the Office of the Chief Scientist, the departmental research conference will include discussions organized around three broad themes (contaminants in food, air and water; children’s health; and genomics and health), while poster sessions will showcase the full range of research and science initiatives conducted by Health Canada. The department’s partners will also be invited to attend and learn more about the department’s science and research activities. For more information, E-mail Stephanie_Wilson@hc-sc.gc.ca

Funding for Health Policy Research

A strategic, targeted contribution program of Health Canada’s Applied Research and Analysis Directorate (ARAD), the Health Policy Research Program (HPRP) generates a range of extramural policy-relevant research designed to meet the needs of the department. HPRP supports research and development projects, policy-relevant projects, workshops, seminars and conferences, and federal/provincial/territorial health research partnerships. Watch for upcoming requests for proposals in Health Canada’s priority areas on the ARAD website (<http://www.hc-sc.gc.ca/iacbd-giac/arad-draa/english/rmdd/funding1.html>).

Infrastructure for Communicable and Chronic Disease Surveillance

The Health Surveillance Working Group (HSWG) has a mandate from the Advisory Committee on Health Infostructure (ACHI) to identify ways and means of enhancing health surveillance in

Canada. Health Canada’s Centre for Surveillance Coordination (CSC) provides secretariat support to the HSWG.

On direction from the HSWG, four breakthrough studies/papers on health surveillance have been undertaken and are now available from the CSC:

- *Data Definitions and Standards for National Notifiable Disease Reporting*
- *Data Definitions and Standards for National Immunization Records Network*
- *National Surveillance for Chronic Disease in Canada — Charting a Path Forward*
- *Situational Analysis for Chronic Disease Surveillance Systems and Networks in Canada*

More information is available at: <http://www.hc-sc.gc.ca/pphb-dgspsc/csc-ccs/> or by calling (877) 430-9995

Biotechnology Surveillance Project

Housed in Health Canada’s Centre for Surveillance Coordination (CSC), the Biotechnology Surveillance Project (BSP) is developing a national surveillance system to monitor potential late health effects on humans of biotechnology products regulated in

Canada. The BSP’s areas of focus include post-market surveillance of bio-engineered vaccines and therapeutics, and post-market surveillance of genetically modified foods.

Recent work in the area of post-market surveillance of genetically modified foods included a *Global Environmental Scan* detailing international efforts in this area and identifying global experts in the field. A follow-up to this work, an international publication on *A System Dynamics Approach to Assessing the Economic Implications of Post-Market Surveillance of Genetically Modified Foods*, was completed



in September 2002. The First International Conference on Post-Market Surveillance of Genetically Modified Foods, hosted by Health Canada on October 16-17, 2002, offered a unique opportunity to position Canada as a global leader in fostering international knowledge sharing and collaboration related to post-market surveillance of genetically modified foods. More information is available at: <http://www.hc-sc.gc.ca/pphb-dgspsp/csc-ccs/>

Mobilizing Population Health

The population health approach is aimed at maintaining and improving the health of all Canadians, as well as reducing inequalities among population groups. A key focus of Health Canada's Population and Public Health Branch (PPHB), the approach directs health improvement interventions toward broad, systemic determinants of health, many of them outside the traditional health care system.

Case Studies of the Regional Mobilization of Population Health — Final Report presents the findings from six initiatives undertaken by PPHB regional offices across Canada, including a cross-case analysis focussing on lessons learned. The results are intended to inform practice in the field and to help market the population health approach to key decision makers in health policy and planning. The document is available on the Population Health website at: http://www.hc-sc.gc.ca/hppb/phdd/case_studies/index.html

Levels of Service in Prenatal Nutrition Programs

A new database provides one-stop electronic access to project-level data and descriptive information about Ontario projects funded under the Canada Prenatal Nutrition Program (CPNP). Compiled by the Healthy Child Development Team, Population and Public

A key focus of Health Canada's Population and Public Health

Branch, the population health approach directs health improvement interventions toward broad, systemic determinants of health, many of them outside the traditional health care system.



Health Branch, Health Canada (Ontario Region), the database allows program consultants to explore and compare individual projects and to identify projects that deviate from Ontario-wide norms. Two reports integrate the information contained in the database with research literature on “best practices” in prenatal programs.

In the next phase of the project, upcoming research on best practices in prenatal programs will be combined with information contained in the database to develop core standards for Ontario CPNP projects. For more information, contact: Nicole_Kenton@hc-sc.gc.ca

Putting the Population Health Approach into Action

The Social Planning and Research Council of BC (SPARC) recently received funding from the Population Health Fund to analyze and synthesize lessons learned in putting the population health approach into action in community-based projects. The result is a document entitled *Creative Spice: Learning from Communities about Putting the Population Health Approach into Action*. Eleven projects focusing on a range of populations and health issues shared their experiences with SPARC. Of

particular interest to policy makers are the discussions about the need to educate a broader array of audiences and to expand community capacity building and the length of community-based initiatives. The project was sponsored by the BC/Yukon Regional Office of the Population and Public Health Branch of Health Canada. The document is available on the Population Health website at: <http://www.population-health.com> 🌐

Mark Your Calendar



| What | When | Theme |
|--|---|---|
| The Pan American Health Organization's Health Promotion Forum in the Americas | October 20-24, 2002 Santiago, Chile http://www.paho.org | Promoting health in the Americas through follow-up on the Mexico Declaration, presenting experiences and good practices, and networking |
| 2002 National Policy Research Conference on Future Trends: Risk | October 23-25, 2002 Ottawa, Ontario http://www.policyresearch.gc.ca | Extending the understanding of risk in the Canadian context |
| Health Research in Rural and Remote Canada: Meeting Challenges, Creating Opportunities | October 24-26, 2002 Halifax, Nova Scotia http://iareh.usask.ca/meetings/brochure.pdf | Various themes, such as community health and Aboriginal health |
| XIXth International Methodology Symposium and Workshops: Modelling Survey Data for Social and Economic Research | November 6-8, 2002 Ottawa, Ontario http://www.statcan.ca/english/conferences/symposium2002 | Subject areas of interest include national statistical accounts and evaluation of social programs |
| 24th Annual Research Conference of the Association for Public Policy Analysis and Management (APPAM) | November 7-9, 2002 Dallas, Texas http://www.appam.org | What if . . .? Assessing the public policy and management implications of social science research |
| Centre for Health Services and Policy Research: 15th Annual Health Policy Conference | November 8, 2002 Vancouver, British Columbia http://www.chspr.ubc.ca/events.htm | Genetic testing: Help, hope or hype |
| Health Canada Research Forum: From Science to Policy | November 18-19, 2002 Ottawa, Ontario E-mail: Stephanie_Wilson@hc-sc.gc.ca | Contaminants in food, air and water; children's health; and genomics and health |
| 12th Annual National Canadian Home Care Association's Conference | November 22-23, 2002 Vancouver, British Columbia http://www.cdnhomocare.on.ca/e-conference.htm | Maximum impact: Home care's role in health care reform — ideas, information, implementation and impact |
| Social Determinants of Health Across the Life-Span: Canadian Perspectives | November 29-December 1, 2002 Toronto, Ontario http://www.socialjustice.org/conference/index.html | A comprehensive examination of issues within a social determinants of health framework |
| Third National Conference on Tobacco or Health | December 1-4, 2002 Ottawa, Ontario http://www.taylorandassociates.ca | Science and policy in action |

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