



North American
Commission for Environmental Cooperation

North American Workshop on Risk Assessment and Children's Environmental Health February 2003

BACKGROUND DOCUMENT

The purpose of this paper is to introduce and provide context for the issues to be addressed at the North American Workshop on Risk Assessment and Children's Environmental Health. It is not intended to be a comprehensive review of the current state of the science nor debate. This paper was prepared by the secretariat of the Commission on Environmental Cooperation (CEC). The views presented here do not necessarily reflect the views of CEC, or the governments of Canada, Mexico, or the United States.

Introduction

Within the context of the Commission for Environmental Cooperation (CEC) initiative on Children's Health and the Environment in North America, approaches to risk assessment, as a basis for regulatory decision-making, is a topic of interest among the three countries. In particular, there is an interest in exchanging experiences and advancing methods and approaches for incorporating the protection of children's health into risk assessment and risk management decision-making.

Risk assessment is widely used and integral to many organizations' decision-making processes. Many multilateral organizations with environmental mandates (World Health Organization, United Nations Environment Programme, Organization for Economic Cooperation and Development), as well as many governments, academics, industries and NGO's, rely on risk assessment as a cornerstone for developing guidance, regulations, and plans of action. Those that use risk assessment typically recognize that there are limitations, challenges, and emerging opportunities for risk assessment processes. There are also ongoing discussions about the role of precaution, transparency and other factors in risk assessment, risk management, and child health protection.

Children's environmental health as a field has grown rapidly. The incorporation of children's unique exposure patterns and susceptibilities into risk assessment is at varying stages of development in the three countries, with many recent and evolving developments. Given the evolving nature of this field, it is an opportune time for collaboration and exchange among governmental agencies and with civil society in the three countries, with a view to advancing the "state of the art" and achieving the common goal of improved protection of children from environmental risks.

Risk Assessment within the CEC's Work on Children's Health and the Environment

In North America, the impact of environmental hazards on children's health is receiving increasing attention among scientists, policy makers and the public alike. Recognizing the need for greater coordination and cooperation to protect children from environmental threats in North America, the CEC launched a special initiative to explore opportunities for involvement in this area in June 1999. The three countries—Canada, Mexico and the United States— committed to “working together as partners to develop a cooperative agenda to protect children from environmental threats with the overall objective of reduction human-made pressures on children's health.”

CEC involvement in children's environmental health issues was initially informed by a trilateral symposium held in Toronto in May of 2000 where experts explored the health and policy issues. Risk assessment was identified as a powerful and useful tool but one that merits further discussion and refinement, particularly when it comes to addressing the particular vulnerabilities and exposure patterns of children. Through this and other public meetings the importance of addressing children's health in risk management activities has also been emphasized.

The CEC's initiative on children's health and the environment was confirmed in June of 2000 with Council Resolution 00-10. As directed by this Resolution, a Cooperative Agenda for Children's Health and the Environment in North America has been prepared as a blueprint for trilateral action.

A trilateral workshop was held in November of 2001 to discuss and develop elements of the draft Cooperative Agenda. Participants included officials from health and environment departments in the three countries, and representatives of the NAFTA Technical Working Group on Pesticides, as well as the CEC's Expert Advisory Board on Children's Health and the Environment. Workshop discussions confirmed interest among the three countries to share information and approaches to incorporating children's environmental health into risk assessment. Participants recommended that the CEC convene a North American workshop focused on risk assessment and children's health.

Further to the November 2001 trilateral workshop, the draft Cooperative Agenda was then reviewed at a joint meeting of the Expert Advisory Board and the Joint Public Advisory Committee (JPAC) in Mexico City in March of 2002, with involvement of the public and stakeholder groups. In response to the proposed actions outlined in the draft Cooperative Agenda, the Mexico City meeting heard public comments and concerns about risk assessment. This feedback included support for the workshop recommended in the Cooperative Agenda to enable broad public discussion of the scientific, economic, cultural, and ethical issues, including the need for transparency and the role of precaution.

The Cooperative Agenda for Children's Health and the Environment in North America was adopted by the CEC Council in June 2002 through Council Resolution 02-06. As part of this Cooperative Agenda (item 4.3), the three parties formally identified the need for a workshop on risk assessment and children's environmental health. A common understanding of risk assessment terms and approaches among the three countries, between environment and health departments, among those dealing with toxic chemicals, including pesticides, and among the public and interested groups —is a prerequisite for effective collaboration and sharing of information and results to ensure that children's vulnerabilities are taken into consideration when assessing risks. Enhanced information exchange between the health and environment sectors can also foster mutually beneficial improvements in risk assessment approaches, particularly with respect to methods for incorporating children's health concerns and vulnerabilities into risk assessment. The roles played by precaution and transparency are important parts of the overall picture. A common understanding of risk assessment and its application in decision-making will also facilitate the sharing of work, expertise, information and ideas, while maintaining the capacity and flexibility of governments to take their own decisions based on the analyses and in light of national/local circumstances.

The Cooperative Agenda (item 4.4) also identified the need to increase the supply of people with training in children's environmental health risk assessment, in order to improve the capacity of governments to assess potential risks to children posed by chemicals, including pesticides. Mexico, in particular, has identified this as a priority need and has initiated a program of risk assessment training. Trilateral collaboration will support the inclusion of a children's environmental health focus within this ongoing training. The three parties have agreed to explore means to increase the number of people trained in children's environmental health risk assessment. A working session during the upcoming workshop in Oaxaca will develop a profile of skills needed for children's health risk assessment, identify possible means by which more people can be trained, and propose actions to increase the number of trained people, for example staff exchanges, training programs at universities and the development of appropriate courses by universities and other training institutions.

Workshop Objectives

This workshop is being organized by the CEC in collaboration with the NAFTA Technical Working Group on Pesticides. The specific objectives identified for the workshop include:

1. To identify areas where the three countries can benefit from the sharing of work, expertise, information and ideas on risk assessment, with a particular focus on children's environmental health.
2. To share country-specific approaches in assessing environmental health risks to children.
3. To facilitate a common understanding of current risk assessment methodologies, principles, terms and concepts among practitioners, and identify emerging approaches, particularly with respect to children's health.
4. To coordinate the sharing of scientific information used within and among jurisdictions (i.e. health, environment, and research sectors) for regulatory risk assessment processes and identify information needs.
5. To identify current capacities with respect to risk assessment for children's environmental health within the three countries, assess future capacity building needs and suggest initial activities.
6. To discuss the context within which risk assessments are used to inform decision-making, including the role of precaution, the need for transparency, outreach, and risk communication.

Risk Based Regulatory Decision Making

Risk based decision-making frameworks have been developed by many governments and organizations. All are intended to provide a structured approach to risk assessment, evaluation, and management. While these frameworks are generally in agreement about broad principles, differences exist in their terminology, level of detail, legislative mandate, process for risk communication, and the involvement of stakeholders.

Some organizations describe a qualitative distinction between risk assessment and risk management, where the former is viewed as a strictly scientific process and the latter as a bureaucratic or political process that considers the range of risk management options in light of many factors (including social, cultural, ethical, political, economic, legal and technical feasibility). From this perspective, risk assessment strives for an objective characterization in quantitative terms of the types and severity of potential harm, arrived at by the most up to date research methods that have the confidence of the scientific community. On the other hand, others reject this distinction because of qualitative judgments that can be built into the process of risk assessment. Other organizational frameworks describe risk management as an overarching decision process, that includes risk estimation, risk evaluation, and risk control.

Various aspects of the theory and practice of risk assessment continue to be debated among risk professionals, policy makers, and the risk-interested public. While professional risk assessors and managers may differ on the way they define key terms, for the purposes of examining fundamental concepts we can think of risk assessment as the process of arriving at a quantifiable estimation of the risk (nature, magnitude, and probability). We can think of risk management as the process of arriving at an institutional decision (within a particular legislative context) on how best to control the risk, what should be done, and implementing the decision.

Fundamental Concepts

Risk and hazard are distinct but interrelated concepts. A **hazard** posed by a chemical, physical, or biological substance is its potential to cause harm to health if it is present in the environment and comes into contact with people or other organisms. Many hazards fortunately can be contained or avoided. A **risk** is the likelihood of adverse health effects occurring when exposure to a hazard occurs, and is thus a function of the severity of the hazard and exposure. Some risks can be measured directly and others are estimated indirectly.

In the field of environmental health, **Risk assessment** is the characterization of the risks associated with exposure to a substance or other agent in the environment. It involves the consideration of the potential of the substance/agent to have harmful effects, the exposures that can lead to such effects, and the likelihood that such effects could occur, given the nature and quantities of releases into the environment, the fate and persistence in the environment, and the resulting exposure that may occur. **Risk management** involves deciding upon and implementing measures to reduce or eliminate the risks associated with the substance in the environment.

Risk assessments range widely in scope and complexity: from simple screening analyses to major assessment efforts that require years of effort and a substantial budget. Contemporary risk assessments ordinarily rely on many branches of science—on the methods and knowledge of disciplines such as toxicology, epidemiology, other health and environmental sciences, systems engineering, and related technical areas.

Health risk assessment

A health risk assessment seeks to identify the kinds of adverse health outcomes that may be associated with exposure to a potentially harmful substance (or some other health-threatening risk agent) and to predict the likelihood that specific human populations will experience such effects at given exposure levels, and to identify sources of uncertainty in scientific data.

Most of the health risk assessments conducted over the past several decades have been directed at estimating the health consequences of exposures to toxic chemicals, with particular attention to the potential for cancer. Accordingly, this emphasis is evident in the concepts, methods, and language used to depict the health risk assessment process. The importance of examining noncancer health effects (such as nervous or immune system impairments, and reproductive and developmental effects) or risk agents other than chemicals is well recognized. Methods for these other kinds of health risk assessments have also developed and are evolving.

The basic components of health risk assessment include:

- **Risk-Source Characterization** (also commonly described as Hazard Identification): a description of the characteristics of the risk source that have a potential for creating risk.

- **Exposure Assessment:** measurement or estimation of the intensity, frequency, and duration of human exposure to the risk source.
- **Dose-Response Assessment:** Characterization of the relationship between the magnitude of exposure and probability that the health effect will occur.
- **Risk Estimation** (also commonly described as Risk Characterization): integrating these steps to produce a measure of the nature and magnitude of the health risk, including attendant uncertainty.

In the past, risk characterizations have consisted of brief descriptions of potential adverse effects and affected populations, along with a single numerical estimate of the level of risk that would summarize whether humans would experience any of the various forms of toxicity or other effects associated with the risk agent. It is now generally acknowledged that characterizations need to provide deeper insight into how risk estimates and findings are generated (including a discussion of the assumptions that underlie the calculations). In addition, characterizations should consider a range of plausible risk estimates and should more clearly discuss the uncertainties and limitations in the empirical data on which the risk assessment is based.

Dealing with Uncertainty

Many environmental health decisions are made through a science-based risk assessment and risk management process with incomplete and uncertain information. Many types of uncertainty and variability are encountered in risk assessment. One way used to address these variabilities and uncertainties is through the use of **safety factors** (also commonly referred to as uncertainty or variability factors) when determining estimates of exposure and effects. These generally 10-fold factors are intended to account for (1) the variation in sensitivity among the members of the human population, i.e., inter-individual variability; (2) the uncertainty in extrapolating animal data to humans, i.e., interspecies uncertainty; (3) the uncertainty in extrapolating from data obtained in a study with less-than-lifetime exposure to lifetime exposure, i.e., extrapolating from subchronic to chronic exposure; (4) the uncertainty in extrapolating from a LOAEL (Lowest-Observed-Adverse-Effect-Level) rather than from a NOAEL (No-Observed-Adverse-Effect-Level); and (5) the uncertainty associated with extrapolation when the database is incomplete.

Risk assessors review and consider the findings of numerous published studies in the process of conducting a risk assessment. These studies often vary significantly in terms of quality. The **weight-of-evidence** approach provides a foundation for risk decision-making under uncertainty. This weight of evidence approach takes into consideration the quality and adequacy of the available studies. It allows risk assessors to evaluate the credibility of conflicting

Variability and Uncertainty (from US EPA 2003)

Variability refers to true heterogeneity or diversity. For example, among a population that drinks water from the same source and with the same contaminant concentration, the risks from consuming the water may vary. This may be due to differences in exposure (i.e., different people drinking different amounts of water, and having different body weights, different exposure frequencies, and different exposure durations) as well as differences in response (e.g., genetic differences in resistance to a chemical dose). Those inherent differences are referred to as variability. Differences among individuals in a population are referred to as inter-individual variability, while differences for one individual over time is referred to as intra-individual variability.

Uncertainty occurs because of a lack of knowledge. It is not the same as variability. For example, a risk assessor may be very certain that different people drink different amounts of water but may be uncertain about how much variability there is in water intakes within the population. Uncertainty can often be reduced by collecting more and better data, while variability is an inherent property of the population being evaluated. Variability can be better characterized with more data, but it cannot be reduced or eliminated. Efforts to clearly distinguish between variability and uncertainty are important for both risk assessment and risk characterization.

evidence about the properties of an environmental contaminant in a systematic and objective manner. In order to ensure that the process of weighing the evidence is scientifically defensible, the weight-of-evidence concept requires that the available evidence is of sufficient strength, coherence, and consistency to support an inference that a serious hazard may exist. Weight-of-evidence does not mean simply tallying the number of positive and negative studies, nor is it an averaging of the results of various individual studies that may be suitable for the risk assessment. The study or studies used are identified by an informed and expert evaluation of all the available evidence. Another development is the use of modern mathematical/probabilistic techniques in risk assessment, which facilitates the treatment of uncertainties in risk calculations. Approaches such as probabilistic analysis for characterizing variability and uncertainty are being explored by the risk assessment community.

In addition to providing a quantitative estimate of risk or a range of possible values, risk assessors should also discuss the assumptions involved in determining the magnitude of risk, the strengths and weaknesses of the evidence used, the significance of any uncertainties that remain, and the implications of any probable alternative assumptions that might have been made in risk calculations. The range of uncertainties in risk assessments should be clearly communicated to decision makers, and methods to address uncertainty should be explicit. The way uncertainty is communicated among stakeholders during risk based decision making, and in the messages provided to the public, can have significant influence on the credibility and effectiveness of the risk assessment and risk management process. Transparency throughout the scientific and decision-making process will ultimately enhance the acceptance and credibility of actions as the treatment of uncertainty and risks are communicated to stakeholders.

Risk is an inevitable consequence of making decisions with incomplete and uncertain information. Sometimes, environmental health decisions must be made under conditions of urgency, with limited information. Deferred decisions constitute an implicit acceptance of the status quo, including the associated health risks and adverse outcomes that may result. At the same time, action may introduce new hazards with uncharacterized and potentially greater risks.

Principle 15 of the Rio Declaration (1992) urges cost effective measures to prevent environmental degradation where there is a lack of scientific certainty and there are threats of serious or irreversible damage. A number of countries, including those party to the CEC, have made contributions to examining the role of precaution and uncertainty in science-based risk assessments, risk management and regulatory decision-making. The role of precaution in risk based decision making is an important part of environmental health discussions today. While some have considered risk assessment and risk management approaches as diametrically opposed to the precautionary principle, many governments now state that risk assessment and precaution work together to inform decision making.

Risk Assessment for Children's Environmental Health

The application of risk assessment to children's environmental health occurs primarily in the setting of health-based environmental standards, e.g., for pesticides, other toxic substances, or air pollutants. Children form a unique subgroup within the population who require special consideration in risk assessment. Children are not little adults. Children have distinct patterns of exposure to environmental chemicals, and they have vulnerabilities that are quite distinct from those of adults. The particular vulnerability of children is due to several factors including often greater susceptibility to environmental toxicants; immature metabolic pathways; rapid growth and development; and longer remaining life expectancy than adults.

Children can have disproportionately higher exposures to many environmental toxicants. Pound for pound of body weight, children drink more water, eat more food, and breathe more air than adults. Thus, children will have substantially greater exposures than adults to toxicants when present in water, food, or

air. Additional characteristics of children can further magnify their exposures, for example, hand-to-mouth behavior, and closer proximity to the ground.

Children's metabolic pathways, especially in the first months after birth, are immature. Their ability to metabolize, detoxify, and excrete many chemicals differs significantly from that of adults. Children are undergoing rapid growth and development, and their developmental processes are easily disrupted thus creating special vulnerabilities. Exposures in early life can give rise to adverse effects that have no counterparts in adult life. The organs of infants and children undergo primary differentiation and very rapid growth prenatally, and depending upon the organ system these processes continue through the first months and even years after birth. Developing systems may not be able to repair damage caused by certain environmental toxicants. Therefore, there is high risk that the resulting dysfunction will be permanent and irreversible.

Because children have more future years of life than most adults, they have more time to develop chronic diseases triggered by early exposures. Many diseases that are caused by toxicants in the environment require decades to develop. Carcinogenic and toxic exposures sustained early in life, including prenatal exposures, in some cases appear more likely to lead to disease than similar exposures encountered later.

Risk assessment continues to develop in the ability to consider the special exposures and the unique susceptibilities of infants and children. The explicit interest and support of child-centered research agendas and risk assessment will continue to improve the identification, understanding, control and prevention of disease in children. The development of child-specific risk assessment methods, improved understanding of mechanisms underlying children's sensitivity to environmental toxicants, and consideration of child-specific toxicity and exposure information are all important considerations.

The scientific basis on how, when, and by how much children differ from adults in their susceptibility to environmental threats must be better understood. In addition, risk assessment methods should be fully adapted to utilize child-specific susceptibility information to improve public health evaluations when such information is available. At this time there is often continued reliance on 10-fold safety factors when the true differences between children and adult susceptibility may be smaller or much larger than the default safety factors. The mechanisms that underlie the susceptibility of children to environmental exposures that are relevant for both toxicity and exposure assessment should be put into the context of the risk assessment framework. The health implications of children's sensitivities can only be understood through the utilization of currently available information regarding child specific hazard and exposure, and support of continued research.

Risk Communication

Risk communication can be defined as the flow of information and risk evaluations back and forth among academic experts, regulatory practitioners, interest groups, and the general public. It encompasses most forms of communication within the process of risk assessment and risk management.

The risk communication process itself can become a focus of much debate. Often this is because two 'languages' are spoken. First, what is called the language of technical risk, is found in formal risk assessments by regulatory agencies, multilateral organizations, and others; and second, the language of perceived risk, which is spoken by the ordinary citizen. Governments straddle the line because they are required to speak both languages. Governments should be able to speak technically and in common language to effectively communicate with different audiences.

Effective risk communication seeks to increase understanding and reduce the level of mistrust among participants. The result assists in making progress towards the ultimate practical objective for risk

communication, namely, the formation of a reasonable consensus in contemporary society on how to assess and manage risks.

The Role of Risk Assessment in Decision Making

Like all decision-making systems and tools, risk assessment has its own strengths and limitations. The strengths of risk assessment include: a structure for collecting, organizing, and evaluating data; a capacity to base policy decisions on the estimated level of human risks; a basis for focusing research efforts on important risk assessment topics; and, in principle, a basis for ranking risks and focusing hazard management resources. Nonetheless, the process has a number of limitations: It can involve exceedingly complex analyses, with much judgmental weighing of diverse data quantity and quality; it is vulnerable to limitations in data and to uncertainties in scientific reasoning; and it requires a good many assumptions, at least some of which will be debatable.

Most experts and policy-makers agree that risk assessment is a valuable tool to inform decisions. And in many cases it is legally required. However, people may disagree about the extent to which risk estimates are biased, about how risk analysis should be used, and how much influence risk assessments should have on government policy.

Some argue that risk assessment is objective and reflects sound science. Others argue that excessive reliance on risk assessment to evaluate problems and solutions ignores other important aspects of policy decisions. Critics also charge that current quantitative methods cannot assess very long-term or newly discovered threats. They also believe that quantitative cost-benefit analysis undervalue health benefits, exaggerate costs, and focus on widespread but individually small costs and risks rather than on much largest costs and risks to smaller, and often more vulnerable groups such as children.

The multilateral, government, academic, and other organizations that rely on and are proponents of risk assessment, understand and acknowledge that there are limitations to the process and availability of data. However, they work to overcome these limitations through various activities, including improved data collection, peer review, improved risk characterization, and the continued establishment and refinement of guidelines to achieve consistency in the conduct of analysis and the presentation of results. There has been considerable progress made in recent years in refining guidance documents and in working to fill the data gaps.

The Role of Stakeholders in Risk Based Decision Making

Involving stakeholders in decisions about how to assess, characterize, and manage risks has gained increasing support over the last decade. While there is widespread acceptance of the concept of public participation, there is still considerable debate on what form it should take—from providing information or expertise in the assessment phase, to participating in consensus based process for risk management decision making.

One concern about the shift towards increased stakeholder involvement in risk based decision making is whether stakeholders can respect and preserve the role of science, in addition to values and perceptions, in informing decisions. Some argue that increased public participation will marginalize the role of science. Others argue that decision making has for too long been dominated by “experts”, and that there should be more emphasis on social values. Variations in conceptions of acceptable risk and perceived risk exist and should be considered. While highly complex scientific approaches are still required to define the risk in technical terms, some argue that equal weight should be given to the stakeholders’ perceptions of risk within the broader context of social and economic conditions.

Future Directions and Opportunities for Children's Health Risk Assessment

Risk assessment has been a cornerstone of risk based decision-making frameworks for many governments and multilateral organizations. Many international trade agreements, including NAFTA, require risk assessment; they do not however specify the methodologies to be applied. Approaches vary in different countries, and within countries risk assessment approaches are always evolving. It can be useful and reliable when the scientific information base is strong. However, there is a well-developed critique of its limitations and children's environmental health issues are increasingly the focal point of these discussions.

The growing evidence of harm to children from environmental contaminants and pesticides will contribute to continued public pressure for regulatory measures that prevent harm. Many opportunities exist for trilateral exchange as risk assessment continues to evolve in general, and in relation to children's environmental health in particular. In the two overarching areas of research and policy, mutual benefits could be gained by learning from and building upon existing experience and, in some cases, expanding ongoing initiatives to a North American scope.

For example, expansion of the research base will improve the quality of all risk assessments. As recommended in the Cooperative Agenda, trilateral expansion of data collection and trends analysis would be particularly valuable for those contaminants with transboundary impacts and that are of concern for children. Such research is necessary across the full range of scientific evidence needed for conducting risk assessments including contaminant exposure, body burdens and health effects. There is an opportunity to build upon ongoing work, such as the currently US-based "Report on Human Exposure to Environmental Chemicals" and the National Children's Study.

This paper has only begun to provide context for the many challenges and opportunities that exist as we work to advance the science of risk assessment to protect children's health and to define its ongoing role in risk based decision making in North America. The three NAFTA countries, through the CEC, have committed to working together to advance understanding of risk assessment approaches with a view to increasing collaboration on toxic substances and increasing the cadre of risk assessors trained in children's environmental health risk assessment.

This workshop is a critical first step. Participants will spend the first day and a half learning and sharing knowledge and experiences on current and emerging approaches and knowledge for children's environmental health risk assessment. The working session on the second day is where participants will build on that learning and sharing of information. Participants will work in groups to identify concrete recommendations for a path forward in the three areas of: information sharing, building capacity, and harmonization of risk assessment terminology and concepts. The final day will provide participants with an opportunity to examine the context within which risk assessments are used to inform decision-making, including the role of precaution, transparency, and risk communication. Before the workshop ends, participants will discuss and confirm a set of workshop conclusions and recommendations for publication in the workshop report.

References

Borouh, M. 1998. Understanding Risk Analysis. American Chemical Society: Washington, DC.
Available from: www.acs.org/govt

Charnley, G. and R. M. Putzrath. 2001. Children's Health, Susceptibility, and Regulatory Approaches to Reducing Risks from Chemical Carcinogens. Environmental Health Perspectives. 109:187-192.

Charnley, G. 2000. Enhancing the Role of Science in Stakeholder-Based Risk Management Decision-Making. Health Risk Strategies: Washington, DC.

Commission for Environmental Cooperation of North America. 2002. Cooperative Agenda for Children's Health and the Environment in North America. CEC Secretariat: Montreal, QU. Available from: www.cec.org

Commission for Environmental Cooperation of North America. 2002. Making the Environment Healthier for Our Kids: An overview of environmental challenges to the health of north America's children. CEC Secretariat: Montreal, QU. Available from: www.cec.org

Cooper, K., L. Vanderlinden, T. McClenaghan, K. Keenan, K. Khatter, P. Muldoon, A. Abelsohn. 2000. Environmental Standard Setting and Children's Health. Canadian Environmental Law Association and OCFP Environmental health Committee: Toronto, ON. Available from: www.cela.ca

Faustman, E. M., S. M. Silbernagel, R. A. Fenske, T. M. Burbacher, and R. F. Ponce. 2000. Mechanisms Underlying Children's Susceptibility to Environmental Toxicants. Environmental Health Perspectives. 108:1:13-21.

Goldman, L. and S. Koduru. 2000. Chemicals in the Environment and Developmental Toxicity to Children: A Public Health and Policy Perspective. Environmental Health Perspectives. 108(3):443-448.

Landrigan, P.J. 1999. Risk Assessment for Children and Other Sensitive Populations. Ann NY Acad Sci. 895:1-9.

Landrigan, P. J. and A. Garg. 2002. Chronic Effects of Toxic Environmental Exposures on Children's Health. Clinical Toxicology. 40(4): 449-456.

Leiss, W. and C. Chociolko. 1994. Risk and Responsibility. McGill-Queen's University Press: Montreal, QU.

McColl, S., J. Hicks, L. Craig, and J. Shortreed. 2000. Environmental Health Risk Management: A primer for Canadians. Network for Environmental Risk Assessment and management: Waterloo, ON. Available from: www.neram.ca

Polifka, J. E. and E. M. Faustman. 2002. Developmental toxicity: web resources for evaluating risk in humans. Toxicology. 173:35-65.

Schierow, Linda-Jo. 2001. The Role of Risk Analysis and Risk Management in Environmental Protection. National Council for Science and the Environment: Washington, DC.

Schettler, T., J. Stein, F. Reich, and M. Valenti. 2000. In Harm's Way: Toxic Threats to Child Development. Greater Boston Physicians for Social Responsibility: Cambridge, MA. Available from: www.igc.org/psr/

United Nations. 1992. Rio Declaration on Environment and Development. Report on the United Nations Conference on Environment and Development. Rio de Janeiro, 3-14 June 1992.

U.S. EPA (Environmental Protection Agency). 2003. A Review of the Reference Dose and Reference Concentration Processes. National Center for Environmental Assessment: Washington, DC. EPA/630/P-02/002F. Available from: <http://www.epa.gov/ncea>