Children's Environmental Health: A Case Study in Implementing the Precautionary Principle

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The plausible threat to children from environmental exposures and uncertainty as to the magnitude and nature of potentially harmful effects provide a rationale for taking precautionary measures to prevent such exposures. The authors present principles for applying precaution to children's environmental health, and policy tools for implementing them. A stronger focus on primary prevention and a better understanding of the risks are needed. *Key words*: precautionary principle; children; environmental health; public policy; prevention; comparative assessment.

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Protection of children from environmental health risks provides a compelling reason for implementing the precautionary principle. Children are not only more generally vulnerable to environmental exposures than adults, they also have little if any control over their environments. Children's unique susceptibility to toxic substances and other hazardous exposures begins in the womb and continues through infancy and puberty. While our understanding of these risks is still very limited, there is sufficient evidence to indicate that the development of some children is already being affected by environmental exposures. Taken together, these conditions—plausible threat of harm and uncertainty as to the magnitude and exact nature of harm—provide a rationale for taking precautionary actions to prevent potentially harmful exposures of fetuses, infants, and developing children. While vigorous government and private efforts in recent years represent a growing acknowledgement of the need to protect children from environmental health risks, a greater focus on primary prevention, in addition to a better understanding of these risks, is needed.

Following a discussion of why precautionary precaution should be applied to children's environmental health risks and the responses to date, we present principles for applying precaution to children's environmental health and selected policy tools for implementing this framework. We conclude that applying precaution to children's environmental health demands the adoption of public health policies that promote the fundamental redesign of production processes, products, and potentially hazardous activities. These actions must be supplemented with research efforts aimed at developing a greater understanding of children's exposures to hazardous substances and the root causes of environmentally-related diseases.

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WHY APPLY PRECAUTION TO CHILDREN'S ENVIRONMENTAL HEALTH RISKS?

The precautionary principle has been defined as "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically."[1] Inherent in this and most definitions of the precautionary principle, dating back almost 15 years, is the notion of preventing the impacts of pollution on future generations. In this respect, the goal of precaution is to establish research and policies to protect those most vulnerable to environmental degradation (and those least able to protect themselves). Protecting those at greatest risk will generally provide health benefits for all in society.

While the susceptibility of children to environmental health risks has been recognized for decades, the publishing of the respected 1993 National Research Council (NRC) volume *Pesticides in the Diets of Infants and Children*[2] brought immediate and international attention to this vulnerability and to a large vacuum in research and policies that recognized this subpopulation. The NRC book marked the beginnings of the new field of "children's environmental health" and a large influx of research, policies, and government and nonprofit initiatives.

With respect to environmental health risks, it has been said on many occasions (including the NRC report) that "children are not little adults." Researchers note that the combination of disproportionately heavy exposure plus biologic vulnerability makes children very susceptible to injury caused by toxicants in the environment.[3] Some of the factors that make children more susceptible to environmental health risks include[2,4-9]:

1. *Rapid periods of growth and development creating windows of vulnerability.* The growth of human cells tissues, organs, and body systems occurs at different rates, with the most rapid periods of development occurring in utero, during infancy, and during puberty. During the first months and years of life, many organ systems, such as the reproductive organs and the immune system, undergo rapid growth and differentiation. Development of some systems, such as the nervous system, is not completed until age 18. During these periods of rapid growth and development, developmental processes are easily disrupted, creating windows of vulnerability where minute exposures can produce irreversible, lifelong effects.

2. *Age-related differences in absorption, metabolism, detoxification, and excretion of toxic substances.* Differences in size, immaturity of biochemical and physiologic functions in major body systems, and variations in body composition (water, fat, protein, and mineral content) can all influence differences in toxicity between children and adults. The metabolic pathways of children are immature when compared with adults, particularly in the first months of life. As such, the ability of a child to detoxify and excrete certain substances is often less than that of adults. Furthermore, children may absorb toxic substances from the gastrointestinal tract differently and to a greater degree than adults.

3. *Greater exposures to environmental hazards.* Kilogram per kilogram of body weight, children drink more water, eat more food, and breathe more air than adults. This means that they have substantially greater exposure to toxic materials present in water, food, and air. Children drink seven times more water per kilogram than does the average adult, eat three to four times more food per kilogram, and have a resting air intake twice that of an adult. Furthermore, children's diets (greater exposures to certain food groups) also increase susceptibility. For example, breast-fed infants are exposed to levels of dioxin that exceed adult exposures by as much as a factor of 50.[8] Behavioral characteristics of early childhood—hand-to-mouth behavior, hours spent close to the ground, and increased time spent outdoors and in small rooms indoors—magnify children's exposures to toxic substances and other hazards.

4. *A longer period of exposure to environmental hazards.* Children are exposed to toxic substances from the fetus and throughout life. Exposures to toxic substances early in life can lead to a greater risk of chronic effects that are expressed only after long latency periods.

There is well-documented evidence that children are being exposed to toxic substances through their food, water, air, and toys. Almost 2.6 billion pounds of chemicals were released into air, water, and land by industrial facilities in the United States in 1997.[8] A metabolite of the pesticide chlorpyrifos is present in the urine of over 90% of children from representative samples.[8] Many other pesticides and industrial chemicals have been identified in the urine, fat, blood, and breast milk of adults and children. One million children in the United States still exceed the currently accepted threshold for blood lead level exposure that affects development.[8] Children are exposed to phthalate esters from PVC toys[10] and medical devices, at levels near those that cause adverse reproductive-tract effects in laboratory animals.[43]

Many of the chemicals and other hazards (e.g., particulates) to which children are exposed have been shown to have adverse impacts in laboratory experiments. Schettler et al.[7,8] and others have identified a wide range of chemical substances that cause adverse reproductive, developmental, or neurotoxic effects. These include: metals (lead, mercury, manganese, arsenic, cadmium); organic solvents (methylene chloride, glycol ethers, trichloroethylene); pesticides (DDT; atrazine, chlorpyrifos, parathion, lindane); tobacco smoke and nicotine; dioxins, and PCBs. Several of these substances have been shown to be "endocrine disruptors," chemicals that mimic or block hormones or otherwise interfere with normal hormonal activity, often at extremely small doses.[7,12] Chemicals identified as endocrine disruptors include dioxins and PCBs, alkylphenols, bisphenol-a, phthalate esters, and various pesticides.

Uncertainty regarding the nature of exposures,[13] specific vulnerability and variability among children, and limited knowledge about the toxicities of chemicals and complex mixtures make it difficult to determine the extent of links between environmental exposures and adverse health effects in children. For example, the U.S. Environmental Protection Agency has estimated that less than 10% of the industrial chemicals produced in the highest volumes (over one million pounds per year) have a full complement of toxicologic screening data. More than 40% have no toxicologic data whatsoever.[14]

Requirements for testing pesticides are more rigorous than those for testing industrial chemicals. But even for pesticides, data relevant to entire categories of health effects—such as reproductive and developmental disorders—may be missing. This has led some analysts to note that "by default, we are conducting a massive toxicological experiment and our children are the experimental subjects."[3]

In general, little is known about the impacts of low-level exposures during windows of vulnerability or the impacts of cumulative and interactive exposures to multiple chemicals and other stressors such as poverty.[7,12] Given the number of chemicals in commerce—over 75,000—and the discovery of more and more ways in which chemicals can disrupt normal functioning, it is implausible that full data sets on toxicity would ever be available for all hazardous substances.

Additional testing and research can reduce much of the uncertainty involving risks to children's health from

environmental exposures, though resources necessary for comprehensive testing of all circumstances would be enormous.* Generating political will to study potential associations or ask questions not asked before can also reduce uncertainty. But some uncertainty results from inherent limitations in our scientific tools, as well as indeterminacy (we cannot control the many unpredictable human factors interacting with human, environmental, and technologic factors), and ignorance (we do not know what we do not know).[17]

In addition to children's unique susceptibility to environmental contamination, there is a growing body of evidence linking certain types childhood diseases and conditions at least partially to environmental exposures. Many people can remember the tragedy of Love Canal. Still, between three and four million children and adolescents in the United States live within one mile of a federally designated Superfund hazardous waste clean-up site.[3] Childhood lead poisoning represents perhaps the clearest example of the impacts that a lack of precaution can have on children's health. Poor and minority children are at increased risk of environmentally-related illnesses because of poor housing and their proximity to both industrial and agricultural production and disposal sites.[18] Evidence pointing to the impacts of environmental exposures on children's health include[6,8,9,19,20]:

- Epidemologic studies have identified associations between childhood exposures to PCBs, mercury, cadmium, lead and some pesticides and neurologic and developmental disorders.
- Rates of asthma in children under 5 years of age have increased 160% in the past 15 years. Substances in indoor and outdoor air are recognized to at least exacerbate and possibly trigger asthma.
- It is estimated that nearly 17% of children in the United States under age 18 suffer from one or more learning, developmental, or behavioral disabilities. Attention-deficit hyperactivity disorder (ADHD) affects approximately 3–6% of all schoolchildren. Research points to environmental exposures as a contributing factor.
- Approximately 8,000 children under the age of 15 are diagnosed as having cancer each year. The incidences of certain types of cancer, such as acute lymphocytic leukemia and brain tumors, have increased over the past 15 years. Some examples of environmental contaminants associated with cancer include: tobacco smoke, asbestos, some hazardous wastes, and some pesticides.

Several factors limit the capacity of epidemiology to discern links between environmental exposures and adverse health effects. These include: long latency periods for some diseases; difficulty in following children over long periods of time; the subtlety of certain health effects; the difficulty of tracking specific exposures (and confounding); and the rare nature of some childhood illnesses. The absence of statistically significant associations may in turn be misrepresented as conclusive evidence of no or minimal risk to children from environmental exposures.

THE U.S. FEDERAL RESPONSE TO CHILDREN'S ENVIRONMENTAL HEALTH RISKS

Since the landmark 1993 National Research Council report, discussed earlier, the U.S. government has undertaken a vigorous and far-reaching program to assess and reduce risks to children's health from environmental exposures. In 1996, U.S. EPA administrator Carol Browner announced a seven-step National Agenda to Protect Children's Health from Environmental Threats. The National Agenda instructs the agency to ensure that EPA standards are protective of children; develop a scientific research strategy to fill gaps in knowledge; develop policies to address cumulative exposures of children; and expand education and the right to know.[21] Browner established the Office of Children's Health Protection to coordinate these activities at EPA.

During that same year, Congress passed the Food Quality Protection Act, the first environmental law to require explicit consideration of risks to children in establishing standards for pesticide residues in food. The 1997 Presidential Executive Order 13045 on Children's Environmental Health calls for Federal agencies to "ensure that [their] policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks."[22] The Executive Order called for the establishment of a research agenda on children's environmental health and establishment of principles and priorities for protecting children's environmental health.

The federal Executive Order resulted in a large-scale mobilization of research and regulatory agencies, as well as academic institutions and nonprofits. The Order created the Cabinet-level task force† charged with recommending strategies for protecting children from environmental threats to health and safety. The task force identified four priority areas for immediate attention—childhood asthma, unintentional injuries, developmental disorders, and childhood cancer—and developed multiagency strategies to meet urgent research and programmatic needs in these areas.[23] The EPA and various agencies of the U.S. Department of Health and Human Services—the Centers for Disease Control and Preven-

*There is also uncertainty that is directly related not to science, but rather to political decisions to not study a hazard or deliberate efforts to conceal risks. The case of lead in gasoline and in paint provides a clear example of the latter.[15,16]

†Task Force on Environmental Health Risks and Safety Risks to Children.

tion, the Agency for Toxic Substances and Disease Registry, and the National Institute of Environmental Health Sciences—have taken the lead in expanding research, outreach, and education on children's environmental health issues. For example, they have established a network of eight academic research centers dedicated solely to the study of children's environmental health risks. This network undertakes wide-ranging research to analyze preventable causes of environmental disease and is charged with translating scientific findings into intervention and prevention strategies.[5] Other agencies have also stepped up their activities. With its Healthy Homes Program, the Department of Housing and Urban Development has expanded its work to reduce risks from lead in housing to include interventions to reduce triggers for asthma and physical hazards associated with childhood injuries.

Despite these promising activities, the vast majority of federal funds spent on health-related activities support screening for hazards and quantification of risks. In some cases, restrictions on emissions of pollutants or uses of industrial chemicals follow. But research and promotion of alternative, less hazardous, approaches to manufacturing, pest control, and other uses of chemicals is scarce and occurs largely in the private sector, disconnected from federal or state regulatory systems. Aggressive action by the government to reduce risks to children from an environmental exposure is very rare, particularly before the risks are fully understood and quantified. The removal of lead from gasoline, tied to subsequent dramatic reductions of levels of lead in the blood of children, is one of only a few examples of this kind of action.

Take, for example, the case of phthalate ester plasticizers in PVC children's toys. The Danish government determined that, taken together, knowledge of exposure, animal toxicity, children's susceptibility to chemical insults, and the availability of alternatives were sufficient to propose a ban on these toys.[24] Elimination of uncertainty was not a prerequisite for taking action. In the United States, the Consumer Product Safety Commission conducted a detailed quantitative risk assessment (estimating exposure through adult volunteers) and arrived at the conclusion that no apparent significant risk existed, but that due to lingering uncertainties industry should voluntarily remove phthalates from toys.[10] The CPSC report did not examine alternatives that would avoid the risks from phthalates.

PRINCIPLES FOR APPLYING PRECAUTION TO CHILDREN'S ENVIRONMENTAL HEALTH

Implementing the precautionary principle in order to better protect children from environmental risks demands a broad reorganization of both environmental science and policy so that it is more effective at anticipating those risks and promoting cost-effective alternatives to hazardous products and processes. The precautionary principle should be viewed as both an overarching principle for environmental health decision making and a guide to individual decisions in the face of uncertainty. This would ensure that "precautionary thinking" is infused throughout the entire decision making process: problem formulation, data collection, assessment of alternatives, weighing of evidence, decision-making, implementation of those decisions. It would lead to decisions that better consider the limits of science and of uncertainty and are more supportive of prevention and innovation. Below we present a set of principles to guide the application of precaution to children's environmental health:

1. Shifting the Questions Asked in Environmental Health Policy

One fundamental change the precautionary principle requires is that scientists and policymakers begin to ask a different set of questions about activities and potential hazards. Instead of asking, "What level of risk is acceptable?" or "How much contamination can a human safely assimilate (usually a healthy male adult)?" they must ask, "How much contamination can we avoid while still achieving our goals?" and "What are the alternatives or opportunities for prevention?" This requires tools to comprehensively analyze not only risks but also feasibility of alternative technologies and products.

The most important aspect of shifting the questions asked in environmental health policy is that it reorients the focus of environmental policy and regulations from analysis of problems to analysis of solutions. Rather than quantifying only the risks of an inherently hazardous activity (emitting a chemical from an industrial facility), assessment of alternatives focuses on what could be done to meet a similar need that would be inherently less hazardous.[25] Examining choices permits a broader range of questions and considerations about activities. It allows for an examination of a product or activity as a whole and whether its purpose can be served in a less harmful and possibly more effective way, rather than simply a narrow examination of one aspect of that activity (the amount of harm it might cause). It allows a more comprehensive range of experience and information (scientific, technologic, etc.) to be used in decision making than does traditional risk assessment. Nonetheless, assessing alternatives will not eliminate the need to assess risks, but this can be done incorporating broader vision for science (see below).

A focus on alternatives may also allow decision makers to partially bypass contentious debates over proof of harm and causality, instead dedicating scarce resources to solutions. It allows precaution to be used as a means of saying "yes" to innovative, cleaner technologies, countering critiques that the principle is used only to stop technologies. Some tools for instituting prevention and assessment of alternatives include: toxics use reduction, pollution prevention, and clean production planning;

environmental impact statements; pre-market testing; labeling; and strict exposure limits (see next section).

2. Shifting Presumptions

In addition to switching the questions decision makers ask about environmental risks, the precautionary principle shifts the presumptions used in decision-making. Rather than presuming that specific substances or activities are safe until proven dangerous, the precautionary principle establishes a presumption in favor of protecting the environment and public health. This switch of presumption places the responsibility for developing information, regular monitoring, demonstrating relative safety, analyzing alternatives, and preventing harm on those undertaking potentially harmful activities. It also empowers government agencies to act to prevent harm and allows them to create disincentives for undertaking potentially harmful activities. Accordingly, in the case of scientific uncertainty, protection of health and the environment are given more primacy than the economic benefit of a hazardous activity. Of course, these tradeoffs are not always black-and-white: a potentially hazardous activity may benefit public health, as in the case of pesticide spraying to reduce transmission of a mosquito-borne virus.

Examples of shifting presumptions exist in public health. Drugs are not allowed on the market until the manufacturer can demonstrate safety and efficacy. Further, pesticides are not judged innocent until proven guilty. However, what is missing in pesticide regulation is the latter steps in the process: assessment of alternatives, less reliance on chemicals, and promotion of non-chemical approaches.

3. A Redefinition of "Sound Science"—Reconfiguring the Science Used for Policy

A critical step in implementing the precautionary principle is to expand the array of scientific tools used to inform policy decisions. Because of the complexity and uncertainties in understanding children's environmental health risks, the science brought to the table needs not only to help reduce uncertainty to the extent possible but also to provide information relative to a preventive, precautionary approach. Science that can best inform precautionary decisions asks different questions and uses different methods than the science historically relied upon by risk managers. These changes in content and method include: broadening hypotheses to examine systems and cumulative and interactive effects of multiple stressors; a greater reliance on interdisciplinary approaches (as has been the case in climate change and endocrine disruption) and information from different constituencies; the integration of critical qualitative information into scientific results; and more explicit discussion about uncertainties (what is known, not known, can be known, and suspected).[26] Decision-making approaches need to go beyond examining risk and causality to considering the magnitude of potential harm, reversibility, temporal and spatial scales, vulnerable populations, and availability of alternatives.[11]

4. Improving democratic methods of participation

A more participative process for decision making under the precautionary principle would likely improve the ability of decision makers to anticipate and prevent harm to children's health. Fiorino[27] has identified several main arguments for more democratic environmental decision-making processes: Non-experts see problems, issues, and solutions that experts miss by thinking more broadly and not being bound by disciplinary constraints; lay judgments reflect a sensitivity to social and political values and commonsense that experts' models do not acknowledge; and the lay public may have a better capacity than experts alone for "institutionalizing regret," accommodating uncertainty, and correcting errors. Finally, broader public participation processes may increase the quality, legitimacy, and accountability of complex decisions.

Given the public nature of environmental decisions, more effective processes for involving those affected by degradation (in this case parents and advocates for children and future generations) are needed. Such processes must be both "fair" and "competent," meaning that they allow all those who want to participate access to the decision-making process from the beginning and that they provide financial and technical resources so that the lay citizen can participate on equal terms with experts.[28] These processes should increase the "decision authority" of affected publics so that their participation is more than token and contributes substantively to the ultimate outcome.

POLICIES FOR IMPLEMENTING A PRECAUTIONARY FRAMEWORK TO ADDRESS CHILDREN'S ENVIRONMENTAL HEALTH RISKS

Based on the previously described principles, a set of policies is needed for implementing a precautionary approach to children's environmental health. The basis of these tools is threefold: 1) reducing and eliminating children's exposures to potentially harmful substances, activities, and other conditions; 2) redesigning production processes, products, and human activities so as to minimize risks in the first place; and 3) establishing goals for restoring human and ecosystem health. Such policy tools need to be supplemented with a research agenda designed to provide "early warnings" to make possible rapid interventions to prevent damage to health. Some policy tools for implementing a precautionary approach to children's environmental health include:

Clean Production and Pollution Prevention

Clean production and pollution prevention involve

changes to production systems and products to reduce pollution at the source (in the production process or product-development stage). This includes reducing the raw material, energy, and natural resource inputs (dematerialization), as well as reducing the quantity and harmful characteristics of toxic substances used (detoxification) in production systems and products.[29,30] A central aspect of clean production is understanding the "service" that a production system or product provides and seeking out safer alternatives to provide that same service (e.g., chlorinated solvents provide degreasing). A majority of U.S. states and many foreign countries have some form of a pollution prevention or clean production program, which have demonstrated success in reducing industrial and product-related pollution, while reducing costs. Swedish hazardous substance law is based on the "substitution" principle, which states that those handling chemical products must take all precautions necessary to prevent or minimize harm to humans or the environment, including avoiding chemical products for which less hazardous substitutes are available.[31]

The Massachusetts Toxics Use Reduction Act represents one concrete, effective application of pollution prevention and precaution. The Act encourages firms to identify ways to reduce their reliance on toxic substances rather than calculate acceptable emissions levels. Firms are required to understand how they use chemicals and for what purposes. They must then develop plans to reduce their waste and use toxic substances and measure progress. In ten years of experience with the Act, toxic chemical emissions have been reduced more than 80%; toxic waste, 48%; and toxics use, 33%, indexed for changes in manufacturing activity. Massachusetts firms have saved more than $15 million in the process, excluding the unquantifiable benefits to health and the environment.[32]

There is an enormous need—and opportunity—to apply clean production and pollution prevention to the design of cities, living spaces, and building materials. The burgeoning "green building" movement provides basic principles for more healthy and environmentally-friendly design that minimizes hazardous and non-hazardous materials; is energy-efficient yet allows sufficient fresh-air ventilation; minimizes build-up of allergens; and sites houses so as to minimize environmental impacts and improve air quality (e.g., designing cities to minimize air pollution from transport and production facilities).

Goal Setting for Environmental Health

Goal setting involves the establishment of aggressive, preventive health goals (e.g., eradication of teen smoking) and development of policies and measures to achieve those goals, while minimizing social disruption (also known as "backcasting"). Goal setting focuses not on what futures are likely to happen but rather how desirable futures can be obtained.[33] Categories of goals include: 1) goals for reducing exposures to hazardous substances, including body burdens (e.g., a 50% reduction in children's body burdens of toxic substances); 2) goals for reductions in hazardous substances and activities (e.g., phase-outs of the most hazardous chemicals); and 3) goals for reductions in the incidences of environmentally related diseases. Goals can also be achieved through the establishment of "red flags," deterrent signals as to which substances and activities are undesirable—for example, lists of chemicals of concern. The northern European countries have been leaders in developing goal-setting processes for environmental health.

In Sweden, Parliament passed a set of Environmental Quality Objectives for the millennium. The overarching goal of these objectives it "to hand over to the next generation a society in which the main environmental problems have been solved." The goals that have been developed are issue-based (water quality, forests, etc). They include implementation steps and measures to track progress.[34]

To achieve the goal of a "nontoxic environment," the Swedish Chemicals Policy Committee developed a set of policies and goals, including: elimination of persistent and bioaccumulative substances from products by the year 2015; elimination of all reproductive toxicants, carcinogens, and mutagens from consumer products by the year 2007; and a progressive phase-out of mercury, cadmium, and lead in products.[35] Implementing this goal requires acknowledging that the chemical-by-chemical risk-assessment process is generally slow and ineffective as well as identifying and acting on characteristics in chemicals that are inconsistent with health and sustainability.[36]

The Danes have also developed a strategy for goalsetting in the area of toxic chemicals.[37] The Danish strategy is based on a goal of protection of the environment so that growth can take place while respecting health and the preservation of animal and plant life. The prevention of health hazards is to be achieved through cleaner technologies. In order to protect the marine environment, discharges of dangerous chemical substances are to be ceased entirely within one generation (25 years), with the ultimate goal of reducing concentrations of substances to near background levels for naturally-occurring substances and to near zero for synthetic substances.

In 1997, the Danish Minister of the Environment established the "Bichel" Committee to evaluate "the overall consequences of phasing out the consumption of pesticides within the agricultural industries."[38] While finding that a complete phase-out of pesticides would not be economically possible, the Committee recommended a strategy for pesticide reduction, including: mandatory use reductions; reduction in exposures; and a changeover to more organic farming methods.

In The Netherlands, goal setting occurs at a firm or sector level, where sectors establish five-year environmental plans (including goals and metrics), and enter into "covenants" with regulators that provide firms in that sector flexibility to achieve the plan's goals unless they

fail to do so, in which case regulations are imposed.[39]

Pesticide Use Reduction/Integrated Pest Management

The use of pesticides in agriculture and general pest control are among the most important environmental risks to children's health. Substitutions of less hazardous chemicals and processes have the potential to substantially reduce those risks. Policies to encourage agricultural production less reliant on pesticides would apply precaution to an important set of children's health risks (both exposures from food residues and exposures of low-income and minority children living near farms).

Policies to reduce reliance on pesticides in buildings would further reduce children's risks. Several local governments and states have enacted pesticide-use–reduction regulations for schools. The Los Angeles Unified School District (the largest in the United States) recently instituted an integrated pest-management (IPM) program that acknowledges the inherent risks that pesticides pose to children. The policy commits the district to select the least harmful method for controlling pests (non-chemical preferred).[40] The recently passed Massachusetts Children's and Families' Protection Act, prohibits the use of the most toxic pesticides at schools and day care centers and requires that these institutions develop IPM plans and notify parents before any spraying takes place. The Consumer's Union and the World Wildlife Fund have proposed a method for tracking progress in pesticide reduction that captures both reductions in toxicity and reductions in overall dependency on pesticides that are inherently hazardous.[41]

A Precautionary Children's Environmental Health Research Agenda

Landrigan[5] and others have argued persuasively for a new paradigm of environmental research that is centered on the needs and exposures of children. Under this paradigm, the child, not the chemical or hazard, is at the center of the analysis. Currently less than 3% of total federal research is devoted to children's health (including environmental), even though children represent 30% of the U.S. population.[42] Children represent the future of our society, yet environmental research is just beginning to consider their unique vulnerabilities. A precautionary children's research agenda would focus on rapid identification of environmental hazards to children's health, as well as potential exposures. It would broaden our understanding of the unique susceptibility of children to environmentally related illnesses. It would take a holistic look at categories of risks and examine root causes and broad-based measures for prevention. It would ask broader questions about risks, to include cumulative and interactive exposures and the effects of long-term low-level exposures and exposures during "windows of vulnerability." The underlying purpose of the research agenda would be to support preventive public health policies to protect children.

CONCLUSION

While children are exposed to a range of both natural and human-made hazards during their development, exposures to toxic substances and other environmental hazards deserve special scrutiny because they are largely preventable. Applying precaution to children's environmental health will require the development of innovative scientific and policy methods and tools that shift the focus of decision making towards primary prevention. It will also require both a willingness and a capacity on the part of government and private institutions to undertake these changes. Nonetheless, this does not mean that we should discard the many useful tools we currently use to assess and reduce environmental risks to children. It does mean that we need to continuously refine and improve upon them as our knowledge of exposures, hazards, and disease progresses.

Precaution should be espoused as much more than a risk-management principle. It needs to apply the content and methods of science used by policymakers to how products, production processes, and activities are designed; to how information is weighed in making a decision; and to who is involved in the decision process. Precaution is driven by respect for human and ecosystem health and for future generations. It depends on more holistic thinking, and acknowledges what we know and do not know. There is no "one size fits all" approach to applying the precautionary principle, as each decision has unique characteristics, affected publics, and levels of scientific evidence and understanding of alternatives.

The original German "spirit" of *Vorsorge* (or foresight), from which the precautionary principle is derived needs to be instilled in efforts to apply precaution to children's environmental health. The *Vorsorgeprinzip* principle takes the future into account and institutes an ethic of aggressive, careful forward planning for sustainability, stimulating both innovation in environmental technologies and job creation.[43] Most articulations of the principle to date, however, have focused on anticipatory action once harm is suspected rather than developing strategies for preventing it in the first place.

Foresight demands that we develop a vision for the type of world we want for our children and aggressively work towards achieving that vision. This vision might include: walking to school without having to cross busy streets; not seeing billboards urging unhealthy behaviors; not being at risk of violence in and out of school; not being born with a body burden of toxic substances; and being able to breathe healthy air, drink uncontaminated water, and eat safe, healthful foods. Current initiatives under way to address environmental risks to children's health provide a unique opportunity to implement the precautionary principle in environmental science and

policy, which can result in a cleaner, safer, and healthier future for all.

References

1. Raffensperger C, Tickner J (eds). Protecting Public Health and the Environment: Implementing the Precautionary Principle. Washington, DC: Island Press, 1999.
2. National Research Council. Pesticides in the Diets of Infants and Children. Washington, DC: National Academy Press, 1993.
3. Landrigan, P, Suk W, and Amler R. Chemical wastes, children's health, and the Superfund Basic Research Program. Environ Health Perspect. 1999;107:423–7.
4. Wargo,J. Our Children's Toxic Legacy: How Science and Law Fail to Protect Us from Pesticides. New Haven, CT: Yale University Press, 1998.
5. Landrigan P. Risk assessment for children and other sensitive populations. In: Bailar J (ed). Uncertainty in the risk assessment of environmental and occupational hazards. Ann NY AcadSci. 1999: 895.
6. Children's Environmental Health Network. Resource Guide on Children's Environmental Health. San Francisco, CA: CEHN, 1999.
7. Schettler T, Solomon G, Valenti M, and Huddle A. Generations at Risk: Reproductive Health and the Environment. Cambridge, MA: MIT Press, 1999.
8. Schettler T, Stein J, Reich F, Valenti M. In Harm's Way: Toxic Threats to Child Development. Boston, MA: Greater Boston Physicians for Social Responsibility, 2000.
9. May M. Disturbing behavior: neurotoxic effects on children. Environ Health Perspect. 2000;108:262–7.
10. United States Consumer Product Safety Commission. The Risk of Chronic Toxicity Associated with Exposure to Diisononyl Phthalate (DINP) in Children's Products. USCPSC, 1998.
11. Tickner J. A map toward precautionary decision-making. In: Raffensperger, C, Tickner j (eds). Protecting Public Health and the Environment: Implementing the Precautionary Principle. Washington, DC: Island Press, 1999: 162-186.
12. Colborn T., Dumanoski D, Myers JP. Our Stolen Future. New York: Dutton Books, 1996.
13. Hubal E, Sheldon L, BurkeJ et al. . Children's exposure assessment: a review of factors influencing children's exposure, and the data available to characterize and assess that exposure. Environ Health Perspect. 2000;108:475–86.
14. United States Environmental Protection Agency. Chemical Hazard Data Availability Study: What Do We Really Know about the Safety of High Production Volume Chemicals. Office of Pollution Prevention and Toxics, USEPA, 1997.
15. Kitman J. The secret history of lead. The Nation. 2000, March 20: 11–43.
16. Markowitz G, Rosner D. Cater to the children: the role of the lead industry in a public health tragedy, 1900–1955. Am J Public Health. 2000;90:36–46.
17. Wynne B. Uncertainty and environmental learning. In: Jackson T. Clean Production Strategies. Boca Raton: Lewis Publishers, 1993: 63–84.
18. Landrigan P, Claudio L, Markowitz S et al. Pesticides and inner-city children: exposures, risks, and prevention. Environ Health Perspect. 1999;107, suppl 3: 431–7.
19. United States Environmental Protection Agency. Asthma and upper respiratory illnesses. Office of Childrens Health Protection, USEPA, 2000. Available at <www.epa.gov/children/asthma.htm>.
20. United States Environmental Protection Agency. Childhood Cancer. Office of Childrens Health Protection, USEPA, 2000. Available at <www.epa.gov/children/cancer.htm>.
21. United States Environmental Protection Agency. Our History. Office of Children's Health Protection, USEPA, 2000. Available at <www.epa.gov/children/whowe/history.htm>.
22. The White House. Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks, April 21, 1997.
23. United States Environmental Protection Agency. President's Taskforce on Environmental Health and Safety Risks to Children. Office of Childrens Health Protection, USEPA, 2000. Available at <www.epa.gov/children/whatwe/fedtask.htm>.
24. Seerdorff L. Head of Division, Danish Environmental Protection Agency. Personal interview, May 21, 1999.
25. O'Brien M. Making Better Environmental Decisions: An Alternative to Risk Assessment. Cambridge, MA: MIT Press, 2000.
26. Barrett K, Raffensperger C. Precautionary science. In: Raffensperger C, Tickner J (eds). Protecting Public Health and the Environment: Implementing the Precautionary Principle. Washington, DC: Island Press, 1999: 106–22.
27. Fiorino D. Citizen participation and environmental risk: a survey of institutional mechanisms. Issues in Science and Technology. 1990; 15:226–43.
28. Renn O, Webler T, Wiedermann P. Fairness and Competence in Citizen Participation. Dordrecht, The Netherlands: Klewer Academic, 1995.
29. Jackson T (ed). Clean Production Strategies. Boca Raton, FL: Lewis Publishers, 1993.
30. Geiser K. Cleaner production and the precautionary principle. In: Raffensperger C, Tickner J (eds). Protecting Public Health and the Environment: Implementing the Precautionary Principle. Washington, DC: Island Press, 1999: 323–36.
31. Wahlstrom B. . The precautionary approach to chemicals management: a Swedish perspective. In: Raffensperger C, Tickner J(eds). Protecting Public Health and the Environment: Implementing the Precautionary Principle. Washington, DC: Island Press, 1999: 51–70.
32. Toxics Use Reduction Institute. Massachusetts Is Cleaner and Safer. Lowell, MA: TURI. 1997
33. Dreborg K. Essence of backcasting. Futures. 1996; 28:813–28.
34. Swedish Parliament. Swedish Environmental Quality Objectives. Government Bill 1997/98:145, passed as 1998/99:MJU6, 1999.
35. Swedish Committee on New Guidelines on Chemicals Policy. Summary of the report of the Swedish Committee on New Guidelines on Chemical Policy. From, Non-Hazardous Products: Proposals for Implementation of New Guidelines on Chemicals Policy. Statens Offentliga Utredningar–SOU 2000:53.
36. Swedish Ministry of Environment, Swedish Environmental Protection Agency, Swedish National Chemicals Inspectorate. Chemicals with Certain Properties Should be Automatically Banned. Swedish Environment. 1998;2:1–2.
37. Danish Ministry of Environment and Energy. A Strategy for Intensified Efforts in the Field of Chemicals—in Demark, in the EU, and Globally. Copenhagen, Denmark, 1999.
38. Danish Ministry of Environment and Energy. The Consequences of Reducing the Use of Pesticides Have Now Been Dlucidated. Faktuelt 21. Copenhagen, Denmark, 1999.
39. van Dunne J (ed). Environmental Contracts and Covenants: New Instruments for a Realistic Environmental Policy? Rotterdam, The Netherlands: Vermanda Lelystad, 1993.
40. Montague P. Preferring the least harmful way. Rachel's Environment and Health Weekly. 2000, January 27: 684.
41. Benbrook C, Groth E, Halloran J, Hansen M, Marquardt S. Pest Management at the Crossroads. Yorkers, NY: Consumers Union, 1996.
42. Olden K, Guthrie J. Children's health: a mixed review. Environ Health Perspect. 2000;108:A250–A251.
43. Boehmer-Christiansen S. The precautionary principle in Germany—enabling government. In: O'Riordan T, Cameron J (eds). Interpreting the Precautionary Principle. London, U.K.: Earthscan, 1994: 31–61.