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Ethical, Legal, and Social Issues: Our Children's Future ☆

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Abstract

A convergence of issues suggests that protecting child health is not so much a matter of research, but rather a matter of policy and advocacy. First, we have well-articulated views of a vision for child health. Second, we have experience and toxicological research findings demonstrating the adverse health effects of hazardous chemicals on children and recognize that children are more sensitive than adults to chemical exposures. Results from toxicology research have motivated many regulatory and legal actions, and public policy decisions, including the banning of some pesticides, reducing exposures in the workplace, and lowering of acceptable blood lead levels in children. We also know that childhood disabilities from chemical exposure during developmental are often not treatable and therefore must be prevented. Finally, we have an increasingly well-defined framework for discussing social and ethical responsibility to our children. New discoveries in the basic biological and toxicological sciences have challenged our bioethical thinking and societal decision-making. This paper will explore the ethical, legal, and social issues raised by the toxicological sciences first by examining some hard lesson learned about childhood effects of chemicals and then by examining the difficult policy and research decisions that must be made as we address our need for additional information about the health effects of chemicals on adults and children and the impact of having this information. The precautionary principle will be considered as an alternative decision-making approach as well as exploring the concept of the citizen toxicologist (CT). As Garrett Hardin pointed out many years ago, the problems we face often have no technical solutions, but rather require a policy-based approach. This paper will be of interest to the public and health professionals concerned about the broader impact of toxicological research on bioethical and societal decision-making.

Keywords: Ethics; Social responsibility; Child health; ELSI

INTRODUCTION

Much of the focus on child health is shifting from reducing mortality to ensuring a child can reach her or his potential. Initially, the diseases of childhood were from infectious diseases and the consequences often fatal. The health outcomes of infectious diseases and malnutrition are now well understood and largely preventable when appropriate scientific and societal resources are employed. Vaccines have eliminated smallpox worldwide and polio is close to being eradicated. Infant mortality has declined worldwide and will decline further as the public health infrastructure improves in developing countries.

The focus is now shifting to one of ensuring children can reach and maintain their full potential and a good quality of life. Scientific research has demonstrated that childhood expose to low levels of chemicals, such as alcohol and environmental contaminates, such as lead adversely affects the developing nervous system. Equally disturbing is the increase in childhood asthma (in 2001, 8.7% or 6.3 million children), cancer, and neurodevelopmental disorders. While the cause or causes are not always clear, these childhood-related

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Fig. 1. UNICEF.

illnesses and disabilities have inspired efforts to better understand chemical exposure to children and resulting body burdens (EPA, 2003). It is estimated that costs associates with the environmentally related childhood diseases is approximately US$ 55 billion per year (Landrigan et al., 2002).

Children (Fig. 1) are often not given priority in policy development or when implementing research findings despite, the fact that the future of society relies on their hands and minds. I believe that in many cases we have more than enough information on the effects of hazardous chemicals on children's health to make rational policy decision to protect health and prevent harm.

A convergence of issues strongly suggests that protecting child health is not so much a matter of research, but rather a matter of policy and advocacy. Recognition of the sensitivity of children to developmental disorders has resulted in multiple visions of child health that take into consideration the unique sensitivity of children. Experience and toxicological research have demonstrated the adverse health effects of hazardous chemicals on children. We are also increasingly aware that childhood disabilities from chemical exposure during development are often not treatable and therefore must be prevented. Finally, we have an increasingly well-defined framework for discussing social and ethical responsibilities to our children. My thesis is that, we have the data from the basic and toxicological sciences to make socially responsible decisions to protect child health. As Garrett Hardin pointed out, many of the problems we face have no easy technical solutions, but must rely on a policy-based approach (Hardin, 1968).

VISIONS OF CHILD HEALTH

How do we envision child health? My own vision is that children should develop and mature in an environment that allows them to reach and maintain their full potential. There are many ways to reduce a child's potential, but here we are focused primarily on the effects of chemicals following exposure during development. This visions stems in part from my own research on the effects of lead and mercury on the developing nervous system, which harms a child's intellectual performance for a lifetime. A broader vision of environmental health is also possible.

A Vision of Environmental and Human Health

"Conditions that ensure that all living things have the best opportunity to reach and maintain their full genetic potential."

National and international organizations have recognized the need to protect the most vulnerable members of society. The World Health Organization (WHO) vision for child health – A world fit for children includes a strong statement promoting child health that acknowledges the importance of children in our society (UNICEF, 2004). UNICEF states that "for every child health, education, equality, and protection advances humanity". The global picture of child health is overwhelmed with concern for children dying from preventable diseases, exploitation, and lack of education.

The U.S. Centers for Disease Control and Prevention (CDC) also has statements on environmental health and child development and acknowledges the importance of investing in our children. The CDC states that "environmental health at CDC strives to promote health and quality of life by preventing or controlling those diseases or deaths that result from interactions between people and their environment" (CDC, 2004). Unfortunately, this broad definition fails to address the unique vulnerability of children to environmental exposures or the life long consequences of exposure. The emphasis on death does not account for the subtler, but life-altering effects or low levels of exposure.

The American Academy of Pediatrics (APA) articulates a more far-reaching definition of child health. The mission and vision of the APA "is to attain optimal physical, mental, and social health and well-being for all infants, children, adolescents, and young adults" (APA, 2004). The APA goes on to state: "To this purpose, the AAP and its members dedicate their efforts and resources. The vision: (1) to advocate for infants, children, adolescents, and young adults and provide for their care; (2) to collaborate with others to assure child health; and (3) to ensure that decision-making affecting the health and well-being of children and their families is based upon the needs of those children and families." I want to emphasize the use of the word advocate here—few organizations so strongly urge their members to advocate for public or child health.

Joining together to express concern about the effects of environmental contaminates on child health the National Institute of Environmental Health Sciences (NIEHS), the U.S. Environmental Protection Agency (EPA), and the CDC jointly fund 12 centers across the United States focused on Children's Environmental health (NIEHS, 2003). Through research and community involvement, these Centers have the goal of reducing "the prevalence, morbidity, and mortality of environmentally-related childhood diseases".

This has been only a small sampling of some of the institutional visions of child health. The vision statements I have highlighted contain lofty goals and I believe in many cases we have data and information to make great progress towards a vision of child health. Toxicological research, epidemiology studies, and the basic sciences provide ample evidence that children are more susceptible that adults to disabilities from chemical exposures. We have the knowledge to implement these goals, but are we effectively translating this knowledge into appropriate policy to protect child health?

Fig. 2. The Mad Hatter.

SUSCEPTIBILITY OF CHILDREN AND THE TOXICOLOGICAL SCIENCES

That children are more susceptible than adults to a wide range of environmental hazards is both well documented and well accepted. By body weight children breathe and eat more than adults, thus increasing their exposure and, due to their small size, receive a greater dose. Age related behaviors, such as crawling and hand-to-mouth behavior increase exposure to a range of compounds. Contamination of dust with pesticides, metals, and other chemicals is well documented as is the exposure of children to these material (Cohen Hubal et al., 2000; Lioy et al., 2002; Simcox et al., 1995). The brain and other organs are rapidly developing making them more vulnerable to chemical exposures (Faustman et al., 2000; Rice and Barone, 2000).

While scientific and public health professionals are well aware of the unique susceptibility of children to this information is not always well understood by the public nor by our local, state, and national government representatives. They often do not appreciate that how easily a child can be exposed to a range of compounds that can harm a child's development.

Knowledge about the vulnerability of the developing organism to environmental contaminates has progressed from the obvious disabilities to the more subtle neurologically related disorders. The hazards of metallic or inorganic mercury have been known since Roman times when slaves labored at a mercury mine in Almaden, Spain; this mine remains active today and continues to be a major mercury source. The health effects of inorganic mercury exposure are classically represented by the Mad Hatter (Fig. 2) in Lewis Carol's, "Alice's Adventures in Wonderland". The effects of mercury on fetal development were recognized in the late 1950s in Minamata, Japan. Mercury released into Minamata Bay by local industry was converted to methylmercury, and then bioaccumulated up the food chain to fish, which were subsequently consumed by pregnant women. However, at the time the path from industrial mercury to methylmercury to fish to the adult women to the fetus and ultimate toxicity was not obvious. The effects on fetal development ranged from the obvious fetal malformations to the far more subtle neurological disorders (Harada, 1968a,b). The consequences of mercury exposure were also demonstrated in Iraq when families consumed seed grain coated with a mercury fungicide that was meant for planting (Marsh, 1987).

During the past decades, the developmental effects of methylmercury exposure have been carefully reviewed and studied clearly documenting affects of fetal development even at very low levels of exposure. (Clarkson, 1992; Gilbert and Grant-Webster, 1995; Rice, 1995). Recognition of the sensitivity of the developing fetus and the developing child to the neurobehavioral effects of mercury has resulted in fish advisories encouraging women and children to limit consumption of certain fish likely to have high levels of mercury.

Recent data from the U.S. EPA indicated that over 630,000 U.S. infants each year have undesirable mercury exposure. Concern over the health effects of mercury-contaminated fish that has resulted in international advisories (UN, 2004), national advisories by the U.S. EPA and FDA, and state advisors, for example, Washington State (WA, 2004). However, implementing these advisory policies has many challenges in part because fish is an important global food source. We must work to educate the public and encourage policy makers while helping them to understand that there is sufficient data to warrant policies and actions to prevent release of mercury into the environment to stop the contamination of fish. These issues have current regulatory significance as decision are made requiring coal fired electric generating facilities to reduce mercury effluent in to the environment.

In his 1903 book, "The People of the Abyss", Jack London described the health of lead exposure on workers in London – "Steel dust, stone dust, clay dust, alkali dust, fluff dust, fiber dust—all these things kill, and they are more deadly than machine-guns and pom–poms. Worst of all is the lead dust in the white lead trades". He then goes on to graphically describe the effects of lead exposure on a young woman. As early as the second BC, it was known that "lead makes the mind give way" and in the 1700s Ben Franklin spoke out on the health effects of lead. Despite these early warnings lead was added to gasoline in 1920s and was used in lead based paint in the U.S. until the 1970s. The developmental effects of even very low levels of lead exposure are now well accepted (Needleman, 2000; Needleman and Bellinger, 1991). Despite this knowledge, lead exposure remains a significant hazard in the U.S. and around the world with significant numbers of children age 1–5 with elevated blood lead levels. In the U.S., elevated lead levels are often the result of exposure from lead-based paint dust (Jacobs et al., 2002). Despite all our knowledge about the neurobehavioral effects of lead, it remains a significant hazard for children throughout the U.S. and in many parts of the world.

Alcohol has been a drug of choice since the accidental fermentation of beer 10,000 years ago. The Greek god of wine, Dionysus, taught the cultivation of vines and frolic in 1500 BC. Some say the combination of wine and lead contributed to the decline of the Roman Empire. But it was not until the late 1960s that we began to better understand the developmental effects of maternal alcohol consumption (Streissguth, 1992; Streissguth et al., 1989). Fetal alcohol syndrome (FAS) is characterized by changes in facial features, growth deficiency, and learning disabilities. The milder fetal alcohol effect (FAE) is associated with learning disabilities and related neurobehavioral effects. In U.S. it is estimated that between 4000 and 11,000 infants suffer from FAS every year and from 7000 to 36,000 infants have FAE. The United States government was relatively slow to develop a policy that incorporated scientific recognition of the fetal effects of alcohol. In 1981, the U.S. Surgeon General first advised that women should not drink alcoholic beverages during pregnancy. Warning labels on alcoholic beverages were not required until 1988. After additional delay, some states require warnings about the developmental effects of alcohol consumption be visible where alcohol is sold. Alcohol is another example of how further study of adverse health effects is not necessary to set policy. Many consumers, women and men, still do not understand the possible subtle consequences of alcohol consumption during pregnancy. Has the current policy approach of labeling and posting warning been sufficient to adequately educated mothers and fathers about the fetal effects of even a small amount of alcohol consumption during pregnancy? Is society doing enough to reduce the most preventable form of childhood learning disability?

There are many more examples of agents that affect the developing nervous system, cause childhood cancer or other disorders such as asthma. Farm raised salmon are contaminated with PCBs and pesticides from pelleted feed and even wild salmon are contaminated with persistent bioaccumulative toxicants. New studies on women's breast milk indicate that it contains a range of contaminants, including the recently noted brominated flame-retardants. How is it that we have added yet another bioaccumulative chemical to breast milk? What are our responsibilities in advocating for polices that protect children's health and potential, given that we have considerable data on potential health effects?

VARIABILITY AND UNCERTAINTY IN DECISION-MAKING

Scientists strive to be objective in interpreting data and arriving at conclusions. The scientific process inherently includes variability and uncertainty. Scientists examine variability and try to minimize uncertainty, in which often leads to the next set of experiments. This process tends to emphasize what we do not know or have doubts about rather than what we do know, in a never-ending quest for certainty and proof of causation. Uncertainty is particularly evident when examining the subtle effects of low-level exposure to an agent. Often the low levels effects of an agent cannot be definitively assigned to an individual, but are only identifiable through large population-based studies.

Decisions are often made with some level of uncertainty or lack of knowledge, so it may be useful to examine different kinds of uncertainty. Statistical uncertainty is perhaps the easiest to examine and possibly reduce. In some studies the value of a variable may not be known or there is excessive inter or intra subject variance. Increases in sample size or inclusion of additional variables may help to reduce statistical uncertainty. Uncertainty of the actual model or system is more serious and results from an incomplete understanding of the relationship between variables within the model system. For example, the mechanism of action may not be well understood at low levels of exposure. Finally, uncertainty may result from just not knowing the right questions to ask. For example, we may not select the most relevant or sensitive health related endpoint to study.

Paradoxically, scientists are both comfortable and uncomfortable with variability and uncertainty. They are comfortable because uncertainty with it is part of science and it even drives the scientific process. Scientists are, on the other hand, uncomfortable because there is often something knowable that might reduce the uncertainty. Some choose to emphasize the uncertainty or the need for further study, which makes decision-making difficult for the policy makers and the public. As we have seen, the resulting indecision, while more data is gathered, leaves sensitive individuals vulnerable to the harmful effects of an agent.

Decisions are easier to make when a specific cause can be established, unfortunately causation can be difficult to establish. Complex disabilities such as deficits in learning and memory can have multiple causes or be confounded by genetics or exposure to several different chemicals. A long latent period from exposure to effect can make determination of causation difficult. Despite these uncertainties decisions must be made.

"All scientific work is incomplete – whether it be observational or experimental. 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 postpone the action that it appears to demand at a given time. "

Sir Austin Bradford Hill (1965)

Bradford Hill defined criteria for determining causation (Hill, 1965). The criteria are briefly summarized below.

1. Strength of association (relationship between independent and dependent variables).
2. Consistency of findings (replication of results by different studies).
3. Biological gradient (strength of the dose–response relationship).
4. Temporal sequence ("cause" before effect).
5. Biologic or theoretical plausibility (mechanism of action).
6. Coherence with established knowledge (no competing hypotheses).
7. Specificity of association (cause is tightly linked to an outcome).

In the past, decisions to protect child health were made only after proof of causation of harm established. There a number of examples were early warnings where not heeded and resulted in widespread harm to the people and the environment (EEA, 2001). For example, overwhelming evidence and many studies were required before it was accepted that low-levels of exposure to lead harms the developing child. The burden of proof was on society to demonstrate harm before action was taken to remove lead form paint or gasoline. In most cases, we now have ample scientific knowledge or experience to make decisions that prevent disease.

ETHICAL AND SOCIAL RESPONSIBILITY

With the above examples, I have suggested that we have much of the scientific knowledge and experience necessary to make rational policy decisions to protect the health of children. We know much more than ever before about the subtle effects on fetal development and child health of a wide range of compounds. With this information come ethical implications and societal responsibilities.

The willingness to make decisions despite uncertainty is supported by an ethical responsibility to children. One framework within which to consider the ethical and social implications of our sciences is biomedical ethics (Beauchamp and Childress, 1994). This approach to biomedical ethics is rooted in four principles: respect for autonomy, nonmaleficence (do no harm), beneficence (do good), and justice (be fair). These duties and responsibilities are grounded in a rich philosophical approach that is well-developed for medically related issues. This approach was primarily directed as an aid to physicians and other caregivers as they considered issues relating to their patients.

While this approach to biomedical ethics is well accepted in the medical community, it does not adequately address the need to prevent childhood exposures to environmental contaminants. The principle of respect for autonomy clearly supports the need to protect child health and well being. This can be expanded to include a duty to create an environment in which children can reach and maintain their full potential. Children have little control over their environment, thus, it falls to adults and society to maintain a healthy environment for children to develop and prosper. In addition, there is an ethical responsibility to share and use our knowledge. In this respect, scientist and public health professionals occupy unique positions in society and have a responsibility to society. Policy makers and the public may not have the knowledge necessary to make informed decisions. Toxicologists and public health professionals have a duty to share their knowledge and advocate for child health. Beyond discussing health-related issues, there is also the need to explain why a certain amount of regulation is necessary.

The problems faced in protecting child health and ultimately their potential often have "no technical solutions". In 1968, about the same time that fetal alcohol syndrome was being defined, Garrett Hardin published a paper on the "Tragedy of the Commons", in which he defined the problem of the Commons (Hardin, 1968). The Commons is classically defined as a shared pasture that becomes unsustainable when one or two members of the group use more than their share of the pasture. Ultimately, the common pasture cannot sustain the increased use; the ecological system of the pasture collapses and everyone suffers. The example of the Commons can be updated by applying fertilizer and pesticides to the common fields and perhaps antibiotics and growth hormones to the cows, but at what cost and to whom. What are the costs to human health and environmental?

There are many other examples of the "commons" from global warming to over fishing the seas. These examples raise a number of challenging issues, but one of the most important concepts is that for many problems there are no technical solutions. Many problems require regulation or policy-based solutions. In a number of situations, our technology has allowed us to extract too much—be it water from the desert aquifers or fish from the ocean. Other problems exist because we did not heed early warning of potential hazard and are left with trying to reduce childhood exposure to lead by removing it, at great expense. Despite all our scientific studies there are no technical solutions to protect children from the effects of fetal alcohol exposure or childhood lead exposure. We cannot engineer a safer glass of wine, while we strive to engineer the best tasting wine. These problems have no current or easy technical solutions. The solution to many of these problems is prevention, which requires a well-educated public and often strong regulatory action.

One approach that promotes a vision of child health, broader ethical principles and action even if there are uncertainties, is the precautionary principle. The precautionary principle has its roots in medicine ("Do not harm") and was implied by Bradford Hill. It recognizes that a new approach to decision-making is necessary given the knowledge and experience that we have acquired with regard to environmental contaminants. The precautionary principle was articulated in the 1992 Rio Declaration as an aid to decision-making in environmental and human health-related issues (Raffensperger and Tickner, 1999). There is growing recognition that a precautionary approach has an important role to play in risk management and policy-making (Goldstein, 2001; Grandjean et al., 2004; Kriebel et al., 2001). There is perhaps no better place to apply the precautionary principle than when considering the health and well being of children. A key element of the precautionary principle as a decision-making tool is making decisions to prevent harm even when confronted with uncertainty. The burden of responsibility is shifted from the public having to demonstrate harm to the proponent of an action having to show that the product or procedure is safe. In other words lack of evidence of harm does not imply safety. While there are a number of definitions of the precautionary principle (Marchant, 2003), the most widely accepted definition of the precautionary principle is from Wingspread Conference in 1998.

"When an activity raises threats of harm to human health or the environment, precautionary measures should be take even if some cause and effect relationships are not fully established scientifically."

Wingspread Conference, 1998.

A precautionary approach to decision-making is well illustrated by how the U.S. Food and Drug Administration (FDA) when making decisions about the introduction of new drugs or food additives into the market place. The manufacturer of a new drug is required to submit data from carefully controlled studies in animals and humans that demonstrate both the safety and efficacy of the product before the FDA give approval to market the product. This is clearly a precautionary approach to decision-making. Contrary to this approach are the rules and regulation with regard to dietary supplements. The Dietary Supplement Health and Education Act of 1994 (DSHEA) says that it is responsibility of the FDA (and thus society) to demonstrate that a dietary supplement is harmful before it can be removed from the market place (FDA, 2004). The manufacturers are not required to show efficacy or safety of their product. For example, ephedra was only recently declared to present an unreasonable risk of illness or injury—after the death a number of people and most recently a baseball player (FDA, 2003). The consequence of this policy approach is that a drug, such as ephedra, was removed only after significant harm had already occurred.

A supportive example of the use of a precautionary decision-making approach is the efforts by the U.S. EPA to implement the 1996 Food Quality Protection Act (Goldman, 1998). Under this law food contaminants must meet a tolerance of ''reasonable certainty of no harm'' standard. One of the goals of this act was to provide additional protections from pesticide risks, especially for children. When fully implemented this would represent a significant change in policy and decision-making approach. However, this does not address the need for far more toxicity data on the approximately 3000 high-production–volume chemicals produced in the United States each year. Many of these chemicals are used in workplace or found in consumer products. The most recent example of limited information on harmful effects of a chemical is brominated flame-retardants that are now being found in women's breast milk.

The precautionary principle is a decision-making tool—an approach to decision-making. It can be used as a framework to assist in an integrated assessment of the human health, environmental issues, scientific facts, uncertainty, and alternatives as well as the ethical, legal, and social implications of decisions. The precautionary principal implies a number of central components.

Central components of the PP are the following:

- Taking preventive action in the face of uncertainty.
- Shifting the burden of responsibility (proof) to the proponents of an activity.
- Exploring a wide range of alternatives.
- Increasing public participation in decision-making.

The precautionary approach to decision-making can be contrasted to a risk assessment based approach. Typically the risk assessment process is complex and driven by scientific experts. There is often a high degree of certainty of harm required before preventive action is taken using risk assessment. Early warnings may be discounted because they are not based on rigorous study design standards. And finally, there is an emphasis on management of risks rather than prevention of harm. Limitation of the precautionary principle should be considered (Marchant, 2003) and risk analysis is certainly useful, but it is essential to have a sound philosophical approach to decision-making (Hrudey and Leiss, 2003).

While an approach to decision-making is important, it should not be over looked that study design, selection of study population, and even what and where to study have ethical considerations (Sharp, 2003). The links between ethics and public health are being explored with the gowing recognition of the social and policy implications of this work (Callahan and Jennings, 2002; Kass, 2001).

EXAMPLES OF THOUGHTFUL ADVOCACY

Citizen Toxicologist

As discussed above, scientist and public health professionals have a responsibility to advocate for child health. This does not mean compromising the science, but rather working to ensure the public and government officials understand the science, uncertainties, and its implications. Social responsibility is a term that is finding its way into our discussions of a civil society. For example, socially responsible investing is broadly defined as acknowledging that your money is powerful and it is important to invest in corporations that consider there place in society as well as making money. This is a proactive attitude—it takes time and effort. Scientists have a similar responsibility to consider the social context of their science and their responsibility to society and to thoughtful advocate for public health.

These principles can be summarized as:

- Ethical responsibility to share and use of knowledge.
- Duty to promote health and well being of children.
- Thoughtful public health advocate.

One approach is to define a socially responsible toxicologist or a citizen toxicologist (CT) to encourage actions consistent with being socially responsible. Toxicologist could receive CT certification renewable each year or perhaps professional societies could award CT certification to deserving toxicologist. The citizen toxicologist is a thoughtful advocate for human and environmental health, who strives to share their scientific knowledge with the public, speaking to public interests rather than private or special interests.

The following are examples of citizen involvement actions:

- Speak to public interests rather than to private or special interests.
- Recognize the ethical, legal, and social implications of toxicological research.
- Share scientific knowledge with public.
- Volunteer time to local groups.
- Testify before local, state, and national government committees and legislatures.
- Meet with local, state or national government representatives.
- Write review papers or other papers for lay public.
- Teach in K-12 class rooms.
- Add expertise to community groups.
- Encourage others to be thoughtful advocates for human and environmental health.
- Become a member of board of directors or volunteer for non-profit organizations associated with human and environmental health.
- Mentor students from K-12 or beyond.
- Lecture or discusses sciences and toxicology issues with public and community groups.
- Volunteer lecture at local community colleges or technical schools.
- Become a member of local speakers bureau.

Seattle, WA – Precautionary Principle Application

Application of the precautionary principle has a number of objectives. Most importantly is a discussion of uncertainties and examination of alternatives. For example, the use of integrated pest management practices in a school system or business—less spray and more looking. Next is examination of direct and indirect costs – for example, business works to externalizing costs on to the public while internalizing profits. The public absorbs the cost of recycling old computers, TVs, and other electronic equipment—thus business manufacturers have externalized the cost while internalizing the profits. Discarded electronic equipment is shipped to developing counties were children are sometimes employed in the dismantling process. A variety of health effects are possible following exposure to toxic metals and other by products of this process. The cost of the process is borne by the children and their society not the purchases of the product. An additional objective of the precautionary principle is to create a more inclusive democratic decision-making process. This can include involving the public consideration of alternatives.

Theoretically, the precautionary principle may sound like a good thing, but how can it be applied in the practical world of government and business decision-making? The precautionary principle was recently endorsed by the San Francisco City Council as a basis for decision-making. In Seattle, we started an initiative to insert a statement about the precautionary principle in the City of Seattle and King County Comprehensive Plans (PPWG, 2004). The Comprehensive Plans are broad plans mandated by Washington State to help plan for growth. The plans typically include land use, transportations and environment elements. In Seattle, a group called the Collaborative on Health and the Environment submitted requests to amend the comprehensive plans to include language on the precautionary principle. We hope the precautionary approach will ultimately lead to a more well informed public and an improved decision-making process.

There are a number of advantages to this effort. Most importantly, it is making a broad philosophical statement addressing the decisions-making process for human health and environmental conditions. In an effort to strengthen the link between the environment and human health, we proposed to change the name of the Environment Element of the Seattle Comprehensive Plan to Environment and Human Health Element. An important objective of this effort was to define a common decision-making principle that would applicable across government departments. A very important additional benefit is that this effort has encouraged a large group of people to work together toward a common goal.

CONCLUSION

We have 30 years of research and experience that demonstrates the adverse effects of chemicals on children. When does this knowledge turn to thoughtful public health advocacy? Everyone has an interest and an ethical responsibility to protect the health and well-being of children—to ensure that they have the best opportunity to reach and maintain their potential. This implies that there is an ethically duty to use our knowledge to protect the health and well-being of others, particularly children.

This responsibilities can be summarized as:

- Children have a right to a safe, fair, and healthy environment.
- Ethical responsibility to share and use of knowledge.

- Duty to promote health and well being of children.
- Thoughtful public health advocate.

There is a convergence of issues that compels knowledgeable scientist to become thoughtful public health advocates. The scientific and business community generates new chemicals each year to satisfy new demands. It is estimates that there are over 70,000 different chemicals in use in the United States and most have little toxicity data. We know from experience that chemicals can damage the developing nervous system, cause cancer or other illnesses. We have the knowledge and means to examine the potential toxicity of the compounds. Furthermore, we know the developing child is more sensitive to chemical exposure that the adult. Experience has also clearly demonstrated that some restrictions on our freedoms is essential to protect public health and in particular child health. Thoughtful public health advocacy that develops policy to prevent disease is far more cost effective than treating disease. Scientists are in a unique position and must consider their ethical and social responsibilities to promote public and child health. In conclusion, I think the most important socially responsible action is to take the time to provide people with the information to make informed decisions.

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