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### **Beyond *The Bangkok Statement*: Research Needs to Address Environmental Threats to Children's Health**

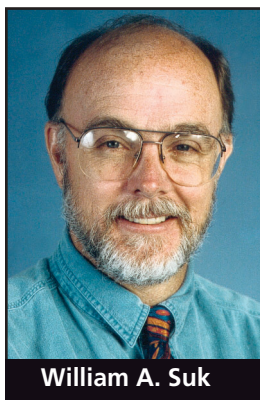
"That all children should have the right to safe, clean and supportive environments that ensure their survival, growth, development, healthy life and well-being. The recognition of this right is especially important as the world moves towards the adoption of sustainable development practices." This quotation from *The Bangkok Statement* (1) reflects the overall focus of the "International Conference on the Environmental Threats to the Health of Children: Hazards and Vulnerability" held in Bangkok, Thailand, 3-7 March 2002. In countries of Southeast Asia and the Western Pacific, as in the rest of the world, environmental contamination results in serious and significant effects on the health of children. The goal of the conference was to highlight the specific environmental conditions existing in Southeast Asia and the Western Pacific that affect the health of these populations, with particular emphasis on children. Participants at the conference hoped to raise awareness of the special vulnerability of children to degrading environmental conditions and to glean recommendations from experts and policy makers in various environmental fields regarding these issues from both an immediate and a long-term perspective. *The Bangkok Statement* is one product of that meeting.

It is true throughout the world that poverty is the major predictor of ill health. This is because poor people are the least able to obtain uncontaminated water and food, receive immunizations and quality health care, and access the information necessary to avoid factors that cause sickness. Poor children, who often scavenge for subsistence, are most at risk for environmental quality problems. They are the most vulnerable and disenfranchised segment of any society. Environmental hazards in conjunction with social stress and malnutrition often pose almost insurmountable barriers to a child's normal development. The health of children under 5 years of age is the most damaged by poor environmental quality (2,3).

Children are highly vulnerable to environmental toxicants. This susceptibility was recognized in the creation of the discipline of pediatrics and was underscored in two seminal studies on pediatric lead toxicity (4,5). This susceptibility arises from the following factors (6):

- Children have greater exposures to environmental toxicants than adults.
- Children's metabolic pathways, especially in the first months after birth, are immature compared with those of adults.
- Children's growth and development occur very rapidly, and their delicate developmental processes are easily disrupted.
- Because children have more future years of life than most adults, they have more time to develop chronic diseases that may be triggered by early exposures.

Exposures to environmental agents at various stages of a child's life, from gestation through young adulthood, can confer differing opportunities for damage (7). Depending on the stage of life, some processes are more active or better controlled than others. Active cellular growth and development occurs during the fetal stages and varies by trimester



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of gestation. Development of brain and certain organ systems is very rapid in the first trimester but slows down in the final trimester. Certain enzyme systems are developed and others are not. Opportunities for mistakes in DNA replication are plentiful, and DNA repair mechanisms in certain cells may not be mature. The fetus is exquisitely

sensitive to exposures of estrogens and other hormones that are needed for growth and differentiation; endocrine-disrupting chemicals from environmental sources may overload the system and cause damage to the developing organism (8). Children may be exposed to environmental agents in a variety of settings that may impact their development (9). These effects, unfortunately, may not be apparent until adulthood. Vulnerability has direct consequences for the risk of diseases of childhood as well as future risk of chronic diseases in adulthood.

The lack of safe drinking water and uncontaminated food is of particular importance, resulting in exposure to infectious organisms and contaminant-induced suppression of the immune system. Contaminated drinking water, which remains a major worldwide environmental health problem, is the major public health issue in many Southeast Asian and Western Pacific countries, where 4 million infants and children die each year from diarrhea (10). Contaminated drinking water is a problem even in some of the capital cities of the region, but it is a particularly serious problem in rural areas where there is no water treatment. In Bangladesh the ground water is naturally contaminated with arsenic, a known carcinogen (11-13). Tragically, up to 25,000,000 people are at risk of cancer, with 900,000 skin cancers expected. Similar problems exist in several parts of China (14). Although not limited to children, the problem of arsenic in drinking water is serious in many areas of the world, and exposure of children to arsenic results in toxicity levels that can develop into cancer and other health problems later in life.

Child laborers often face environmental exposures while on the job. Children who work in paint pigment factories, for instance, are exposed to various organics, dyes, and solvents. Another custom common in Asia is for families to live on the site of the father's employment, which can result in occupational exposures for the children as well. Furthermore, a tolerance of risk by the public exists in some developing countries that would never be acceptable in the West. For example, welding is often performed without safety glasses and, even more detrimental, industrial waste is discharged into streams in which children sometimes play.

Vietnam has a unique, but significant, problem as a result of Agent Orange that was sprayed over wide areas of the former South Vietnam during the war in the late 1960s and early 1970s. Almost 19 million gallons of Agent Orange were applied during the war. Hung

and colleagues (15) reported on the incidence of birth defects and adverse reproductive outcomes in three communities where Agent Orange was heavily applied. Further study is needed to determine if paternal exposure is a factor in these birth defects. A recently signed Memorandum of Understanding between Vietnam and the United States on the health and environmental effects of Agent Orange/dioxin (16) should help to address these issues.

Air pollution, both indoor and outdoor (60% from traffic and 40% from industry), is a major problem for the children in the Philippines. A Clean Air Act, initiated in early 2001, is phasing out the use of leaded gasoline in the Philippines. Lead levels in children are high, however, not only from the lead in gasoline but also from the extensive mining operations and battery recycling plants. Mercury, cadmium, and copper poisonings are also of concern. Urban air pollution is an enormous problem in many of the large cities, as has been documented for Singapore (17,18); Hong Kong; Taiwan City, Taiwan (19); and Ulaanbaatar, Mongolia (20).

Children in many Southeast Asian and Western Pacific countries also experience significant exposure to various organic chemicals, including pesticides, solvents, polychlorinated biphenyls (PCBs), and dioxins (20). In Indonesia, the use of DDT in agriculture continues, even though it was officially banned years ago. Many other dangerous, persistent, and often illegal pesticides continue to be used (20). In a study in Cambodia, 23% of 6- to 12-year-old children in the village of Siem Reap suffered from skin lesions secondary to pesticide exposure (20). In these cases, the exposure came both from the living and play areas and from child labor in the agricultural fields. In general, in this area of the world, there has been little study of PCB exposure, primarily because of the cost of analytic measurements.

Further research is needed in Southeast Asia and the Western Pacific to study the consequences of exposure to environmental agents, children's health, and the relationship between that exposure and disease outcome. From a scientific perspective, it is of critical importance to determine whether children have been exposed to environmental toxicants, the route of exposure, the levels and timing of exposure, and whether the substance has reached the target organ or cell. Equally important is to determine if the exposure results in changes in normal physiologic processes that could lead to disease or dysfunction. Although these fundamental relationships are difficult to address, more effective prevention/intervention strategies are being developed via the continued advancement of exposure models, validation of biomarkers of exposure, effect and susceptibility based on mechanistic data, and the application of these to epidemiologic studies.

Although the effects of exposure to neurotoxic substances such as lead, mercury, PCBs, and pesticides are not easily quantitated, such exposures pose an enormous threat to the health of children in many countries in this region of the world. Because these exposures are often at levels that do not cause obvious or immediate illness, their impact on the society receives less attention (21). Nevertheless, these exposures have been associated with a reduction of intelligence quotient (IQ) and attention span in many individuals, which can have an enormous effect on the overall productivity of a population (22,23). With a high incidence of lead and mercury elevation and a potentially widespread contamination with pesticides, PCBs, and dioxins, the effects of these individual contaminants may be additive or even synergistic.

In the more developed countries of Southeast Asia and the Western Pacific, asthma reigns as the major health hazard to children. The distribution of asthma among these countries is somewhat different from that observed in the United States. In the United States, asthma incidence is particularly elevated in poor, inner-city populations (24). In Southeast Asia and the Western Pacific, however, asthma is particularly elevated in the more affluent countries (i.e., Japan, Singapore, and Australia). For example, in Singapore, 1 in 5 children has asthma (25); another 1 in 5 reports symptoms of asthma, but has not been formally

diagnosed with the disease (26). It has been estimated that 8.4% of all children worldwide suffer from asthma (26).

Many questions remain unanswered with regard to the consequences of environmental exposures on children in Southeast Asia and the Western Pacific. The combined effects of urban and industrial growth in the region have generated a number of increasingly serious environmental problems. Chief among these are the overexploitation and contamination of ground and surface water resources; the lack of proper disposal or recycling of liquid, solid, and hazardous waste; air pollution; and inadequate environmental infrastructure. International cooperation on trade and the environment has set the stage for new initiatives and collaborative efforts aimed at preventing pollution and promoting sustainable development. These efforts will require the development of environmental exposure models as well as coordinated regional studies of environmental health issues.

Patterns of illness in children changed dramatically in the last century and will continue to change in this century. The major diseases confronting children now are chronic and disabling conditions termed the "new pediatric morbidity": asthma, leukemia and brain cancer, neurodevelopmental dysfunction and neurobehavioral abnormality, and reproductive and systemic developmental problems. Chemical toxicants in the environment, poverty, racism and sexism, and little or no access to health care are all factors contributing to life-threatening pediatric diseases. Children are at risk of exposure to thousands of chemicals that are used widely and are dispersed in the environment. Children are uniquely vulnerable to chemical toxicants because of their disproportionately heavy exposures and their inherent biological susceptibility. Therefore, the protection of children against toxicants in the environment is a major challenge to society worldwide.

The Southeast Asia and Western Pacific region presents unique preventive research opportunities. Based on current health concerns and recommendations (20), it is important to develop and implement a multidisciplinary research program that will bridge research gaps and meet the needs of investigators and affected communities to improve the overall public health of children who live in Southeast Asia. A program designed to investigate chemical, physical, and social exposures in children in the Southeast Asia region and the resultant health effects needs to be established and effectively managed. In addition to basic research, prevention/intervention research needs to be a facet of the program and should include community-based participatory research.

There is a need to obtain better and more coordinated local and global data collection on environmental exposures in children throughout Asia and to relate these exposures to disease outcomes. It would be a great benefit to develop a global, strategic, epidemiologic effort to understand the relationship between environmental exposure and ill health in children. In doing this we need to consider the entire environmental pathway, from driving forces to health impact, with design interventions that will improve the environmental health of all children.

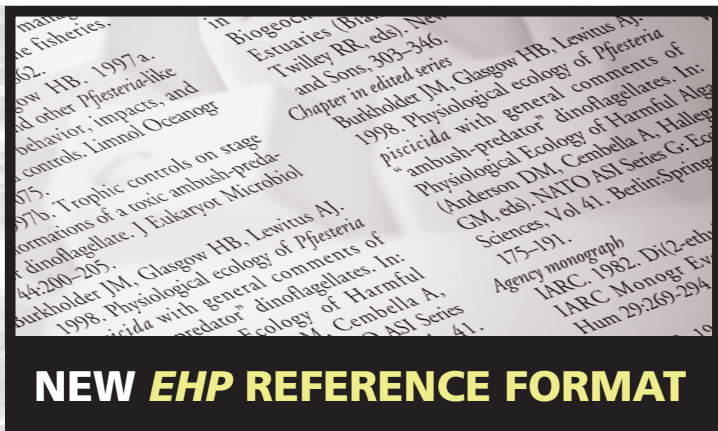
Finally, it is imperative that we develop a better understanding of the mechanisms and interactions among nutrition, infectious disease, environmental exposures, and genetic predisposition in order to develop better prevention methods. Although the environmental health threats to the children of the Southeast Asia and the Western Pacific region are not unlike those of children in the rest of the world, their unique circumstances need to be addressed using rigorous scientific and prevention strategies. *The Bangkok Statement* is an outstanding beginning to addressing the many difficult environmental health issues facing children, and needs to be actively embraced by all.

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