A Challenge to Health-Care Providers -- Changing Patterns of Disease: Human Health and the Environment

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by Ted Schettler, MD, MPH*

For most of us, genetic inheritance plays a limited role in determining our health. More important is where and how we live, work, and play -- the quality of what we drink, eat, and breathe. From the time of conception, throughout development, and into early and late adulthood, environmental factors either directly impact biological tissues or influence gene expression and shape subsequent disease risks.

Although links between exposures to environmental contaminants and health impacts have been known for centuries, recent research documents an expanding list of previously unrecognized effects after fetal or infant exposures.[1] The developing fetus and child are particularly vulnerable to toxic insults. During this time cells are rapidly dividing, and growth is dramatic. Various events, including development of the brain and endocrine, reproductive, and immune systems, are uniquely susceptible to disruption that is often permanent. To compound the problem, pound for pound, children are often disproportionately exposed to toxic environmental agents because of the way they breathe, eat, drink, and play. Moreover, immature detoxification pathways in children frequently result in increased impacts of toxic exposures when compared to adults.

Small exposures to substances like lead, mercury, or polychlorinated biphenyls (PCBs), which have no discernible impact on adults, can permanently damage the developing brain of a child, if the exposure occurs during a window of vulnerability. Early exposures to dioxin or polychlorinated biphenyls (PCBs), chemicals from industrial activities that bioaccumulate in dietary fat, damage the developing immune system, making the child more prone to infections.[2] Risks of asthma and high blood pressure are increased by early environmental exposures.[3,4] Recent research from Sweden concludes not only that environmental factors play a more important role than genetic inheritance in the origin of most cancers, but also that cancer risk is largely established during the first 20 years of life.[5,6]

Technological developments have dramatically reduced mortality resulting from many diseases. In many instances, however, disease incidence is increasing, although for some conditions without standardized tracking mechanisms, trends are difficult to determine accurately. The burden from current patterns of disease and disability is enormous and extracts a terrible toll from individuals, families, and communities. Nearly 12 million children in the U.S (17 percent) suffer from one or more developmental disabilities, including deafness, blindness, epilepsy, speech defects, cerebral palsy, delays in growth and development, behavioral problems, or learning disabilities.[7] Learning disabilities alone affect 5 to 10 percent of children in public schools, and these numbers appear to be increasing.

Attention deficit hyperactivity disorder conservatively affects 3 to 6 percent of all school children, and the numbers may be considerably higher. The incidence of autism seems to be increasing, though much of this apparent increase may be due to increased reporting. The age-adjusted incidence of melanoma, lung (female), prostate, liver, non-Hodgkin's lymphoma, testis, thyroid, kidney, breast, brain, esophagus, and bladder cancers has steadily increased over the past 25 years.[8] Some birth defects, including disorders of the male reproductive system and some forms of congenital heart disease, are increasingly common.[9,10] Sperm counts and fertility are in decline in some areas of the U.S. and other parts of the world.[11] Asthma is more common and more severe than ever before.[12] Genetic factors explain far less than half of the population variance for most of these conditions. Although smoking and sun exposure are well-recognized risk factors for some conditions, improved understanding of development of the brain and the immune, reproductive, respiratory, and cardiovascular systems leads to the conclusion that other environmental factors play a major role in determining current patterns of disease.

To the limited degree that health care providers address environmental factors at all, most focus nearly all of their attention on personal behaviors, like smoking, substance abuse, or use of sunscreens. These are more easily addressed by individuals than more complex problems like air and water pollution, hazardous waste sites, agricultural systems that inevitably result in farmworker pesticide exposures, and mercury contamination of dietary fish. Global environmental conditions, however, are changing, along with the changing pattern of disease and disability, and our increasing understanding of the importance of environmental factors in determining the health of individuals and populations places a new and special responsibility on the medical profession.

Consider that:[13,14]

** Over 6 billion people inhabit the planet, and reasonable mid-level estimates predict 9 to 10 billion by mid-century. Two-and-a-half more "earths" would be needed to support today's population if everyone were to use as many resources as Americans do on a per capita basis.

** The release of ozone-depleting chemicals used for industrial and agricultural purposes has depleted the stratospheric ozone layer and is likely a major contributor to the increased incidence of malignant melanoma.

** Carbon dioxide concentration in the atmosphere has increased by nearly 30 percent in the last 150 years. Carbon dioxide is a greenhouse gas that contributes to global warming. Hazardous air pollution, in general, is the norm in most parts of the U.S. and elsewhere in the world.

** Humans are responsible for more atmospheric nitrogen fixation than all other sources combined. Nitrates contaminate groundwater, surface water, and air at toxic concentrations.

** Humans are responsible for most of the mercury deposition on the surface of the earth. Mercury makes its way into the food chain, where it bioconcentrates. In most states, freshwater

and marine fish are sufficiently contaminated with mercury to require warnings to women of reproductive age to limit consumption because of risks to fetal brain development.

** Large numbers of plant and animal species have been driven to extinction, and most marine fisheries are severely depleted. More than half the world's coral reefs are threatened by human activities.

** In addition to naturally occurring products like lead and mercury that are mined from the earth, novel synthetic industrial chemicals contaminate the world's ecosystems, its human and non-human inhabitants, their breast milk and egg yolk, ovarian follicles, amniotic fluid, and meconium. The toxicity of most is little known.

** Of the approximately 85,000 chemicals on the federal inventory, nearly 3,000 are produced in excess of 1 million pounds annually. For these high-production volume (HPV) chemicals, toxicity data are surprisingly sparse. Even basic toxicity testing results are not publicly available for 75 percent of them.[15] In the U.S., according to the 2000 Toxics Release Inventory, over 6.2 billion pounds of the listed toxic chemicals, including 2 billion pounds of known or suspected neurotoxicants, were released into the environment by major emitters required by federal law to file reports. Emissions from small industries and neighborhood shops are unquantified. The extent of exposure from these releases and from the use of various consumer products that contain them is also largely unknown, but population-based surveys give an indication of the ubiquity of exposures.[16]

As the industrial revolution has continued to unfold over the last century, humans have fundamentally altered the local and global environment. We see signals and changing patterns in the development of children and subsequent occurrence and distribution of disease that deserve serious attention. The medical community is challenged to widen its scope of responsibility to embrace a more ecological assessment and response to the emerging pattern of disease and disability.

Early in their training, health care providers are taught to inquire into the family and social history of their patients or clients. This is not enough. Specific knowledge of the home, community, workplace, and school environment is essential for identifying risks and mapping preventive strategies. Medical education needs to incorporate into the curriculum new understanding of the role of the environment in the development of disease and disability. Health clinicians can also play important roles in policy debates at the community, state, or national level. The division between medical practice and public health practice that began in the early 20th century has not narrowed nearly enough. Health care providers can become strong advocates for clear air and water, for communities free of hazardous waste sites, and schools free of toxic chemicals and mold.

The public supports a large medical-industrial complex, but that support is not limitless. It is time for the medical community to re-examine its priorities and social contract with the public, and to integrate fully and creatively into routine medical care what we know about the causes of the changing pattern of diseases and disabilities.[17]

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* Dr. Schettler is on the medical staff of Boston Medical Center and has a clinical practice at the East Boston Neighborhood Health Center. He is science director of the Science and Environmental Health Network (http://www.sehn.org). Dr. Schettler is co-author of GENERATIONS AT RISK: REPRODUCTIVE HEALTH AND THE ENVIRONMENT, which examines reproductive and developmental health effects of exposure to a variety of environmental toxicants. He is also co-author of IN HARM'S WAY: TOXIC THREATS TO CHILD DEVELOPMENT, which discusses the impact of environmental exposures on neurological development in children. (See Rachel's #712.)

[1] National Research Council. SCIENTIFIC FRONTIERS IN DEVELOPMENTAL TOXICOLOGY AND RISK ASSESSMENT. National Academy Press, Washington DC, 2000.

[2] Weisglas-Kuperus N, Patandin S, Berbers G, et al. Immunologic effects of background exposure to polychlorinated biphenyls and dioxins in Dutch preschool children. ENVIRONMENTAL HEALTH PERSPECTIVES 108(12):1203-1207, 2000.

[3] Sorensen N, Murata K, Budtz-Jorgensen E, et al. Prenatal methylmercury exposure as a cardiovascular risk factor at seven years of age. EPIDEMIOLOGY 10(4):370-375, 1999.

[4] Peden D. Development of atopy and asthma: candidate environmental influences and important periods of exposure. ENVIRONMENTAL HEALTH PERSPECTIVES 108(suppl 3):475-482, 2000.

[5] Czene K, Lichtenstein P, Hemminki K. Environmental and heritable causes of cancer among 9.6 million individuals in the Swedish family-cancer database. INTERNATIONAL JOURNAL OF CANCER 99:260-266, 2002.

[6] Hemminki K, Li X. Cancer risks in second-generation immigrants to Sweden. INTERNATIONAL JOURNAL OF CANCER 99:229-237, 2002.

[7] Schettler T, Stein J, Reich F, Valenti M. IN HARM'S WAY: TOXIC THREATS TO CHILD DEVELOPMENT. Greater Boston Physicians for Social Responsibility, 2000. http://www.igc.org/psr

[8] SEER Cancer Statistics Review, 1973-1996. Bethesda MD: National Cancer Institute.

[9] The Pew Environmental Health Commission. http://pewenvirohealth.jhspu.edu

[10] Paulozi L. International trends in rates of hypospadias and cryptorchidism. ENVIRONMENTAL HEALTH PERSPECTIVES 107(4):297-302, 1999.

[11] Swan S, Elkin E, Fenster L. Have sperm densities declined? A reanalysis of global trend data. ENVIRONMENTAL HEALTH PERSPECTIVES 105:1228-1232, 1997.

[12] The Pew Environmental Health Commission. http://pewenvirohealth.jhspu.edu

[13] Vitousek P, Mooney H, Lubchenco J, Melillo J. Human domination of earth's ecosystems. SCIENCE 277:494-499, 1997.

[14] LIFE SUPPORT: THE ENVIRONMENT AND HUMAN HEALTH. Ed: McCally M. Cambridge, MA: MIT Press, 2002.

[15] Environmental Defense Fund. TOXIC IGNORANCE: THE CONTINUING ABSENCE OF BASIC HEALTH TESTING FOR TOP-SELLING CHEMICALS IN THE U.S. 1997.

[16] Centers for Disease Control and Prevention. NATIONAL REPORT ON EXPOSURE TO ENVIRONMENTAL CHEMICALS. 2001. www.cdc.gov

[17] Lubchenco J. Entering the century of the environment: a new social contract for science. SCIENCE 279:491-497, 1998.