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Review article

The chemical erosion of human health: adverse environmental exposure and *in-utero* pollution – determinants of congenital disorders and chronic disease

The first 38 weeks of human life spent in the allegedly protected environment of the amniotic sac are medically more eventful and more fraught with danger than the next 38 years in the lifespan of most human individuals.

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Abstract

Epidemiological research designed to explore causality of illness has produced increasing evidence to verify that exposure to toxic agents is contributing to the escalating burden of chronic affliction, including congenital disorders. While endeavoring to facilitate optimal health and well-being for patients, the medical profession is currently challenged by the consequences of environmental factors unique to the modern era. In the last half century, there have been profound shifts in health-related habits of individuals and population groups, and recent research suggests that changes in the home and workplace environment are responsible for many common health problems including various congenital anomalies. As a result of increasing concern about environmental influences on health, 'Human Exposure Assessment,' the investigation and study of specific patient exposures and related health concerns, is a rapidly expanding area of scientific research. Practitioners of clinical medicine, including providers of maternity care, should acquire the skills to elicit a proper environmental exposure history and the necessary tools to implement proactive patient education relating to precautionary avoidance.

Keywords: Chronic disease; congenital anomalies; endocrine disrupting chemicals; environmental health; hormone disruption; human exposure assessment; precautionary avoidance; preconception care; prenatal care; toxicology.

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Introduction

As well as the economic burden on public health care systems, the birth of a child afflicted with a disability presents myriad challenges to caregivers. The physical attention and health care involved, the lingering uncertainty about the social and educational future of the disabled offspring, and the anxiety regarding lifelong maintenance issues often result in enormous stress and compromised well-being for families. The recent announcement that an unprecedented one out of every dozen children in America has a physical or emotional disability [32], juxtaposed with a report that all of 327 parturients previously enrolled in a preconception program in the UK delivered healthy offspring [144], raises intrigue about the underlying etiology of various congenital disorders. When the author reviewed the medical literature in pursuit for an explanation, it became apparent that environmental and toxicological factors are significant determinants of many contemporary health issues, including birth deformities. As few medical schools include courses about environmental medicine in their curricula [50], awareness of toxicants as ubiquitous determinants of impaired health is often lacking among physicians and few practitioners have acquired the necessary skills to investigate and manage exposure-related illness [89].

Trends in chronic Illness

Although life expectancy has improved over the last century in developed nations in large measure due to the immense progress at reducing infant mortality, the expanding prevalence of chronic and degenerative illness

Table 1 Selected trends in American Public Health.

Disorder	Incidence status
1. Major birth anomalies	Males 3.9% [76] Females 2.8% [76]
2. Congenital hypospadius	Increased by >75% from 1970 to 1991 [124]
3. Autism	Increased by more than 500% from early 1980s to 1996 [156]
4. Developmental disabilities	About 17% of children [18]
5. Pediatric attention deficit disorder	Dramatic recent increase in diagnosis and drug treatment [113, 118]
6. Breast cancer	Increased by >35% from 1973 to 1997 [124]
7. Testicular cancer	Increased by >60% from 1973 to 1997 [124]
8. Sperm count	Declined by >40% from 1930 to 1990 [124]
9. Asthma (self-reported)	Increased by 73.9% from 1980 to 1996 [81]
10. Preterm birth	Increased by 23% in white infants from 1981 to 1998 [19]
11. Hysterectomy	Increased by 24% between 1996–2002 (~670,000 performed annually) [75]
12. Childhood cancer	Increased by 27.1% from 1975 to 2002 [13]

of late is debilitating many health care systems [68, 94, 96, 143, 155]. A browse through the medical literature reveals that the tentacles of chronic disease and ill-health are increasingly evident in a wide variety of medical specialty areas (Table 1). A few examples illustrate the situation.

Reproductive problems including infertility, altered sexual functioning, gonadal changes and endometriosis afflict countless patients worldwide [6, 45, 105, 111, 124, 125]. Gynecological bleeding problems are now so commonplace that more than half a million American women undergo hysterectomies annually [75] with 20% of Canadian women over age 35 having already lost their uterus [82]. A 2004 World Health Report highlighted the rapidly increasing number of individuals worldwide who struggle with all the physical, social and emotional consequences of cancer [154]. Autoimmune disorders, chronic fatigue syndrome, fibromyalgia, allergies, mental illness, and various other afflictions diminish the health and well-being of innumerable adults. Chronic illness is not only a problem in the adult domain: recent figures suggest that many chronic afflictions in children are on the rise including asthma, allergic disease, behavioral disorders and metabolic problems such as diabetes. How do these infirmities and other health problems relate to environmental and toxicological considerations?

In the last half century, there have been profound shifts in the health-related habits and exposures of individuals and population groups, and recent epidemiologic research suggests that changes in the environment and exposure to various toxicants may be responsible, in part, for escalating rates of some chronic disorders. While widespread advertising campaigns that discourage alcohol intake in pregnancy and recent legislation restricting smoking in public places represent the awareness of chemical toxicants and health sequelae, many health providers are not cognizant of numerous other health threatening toxins. Various organizations have endeavored to emphasize this issue to the medical community.

Toxicology and health

The Environmental Protection Agency (EPA) [138], the World Health Organization (WHO) [152], the US Centers for Disease Control (CDC) [95] and recently published scientific literature [57, 74, 147] draw attention to changes within the environmental milieu of workplace, home, and general community that are negatively affecting human health. Increasing scrutiny of the emissions generated by the plethora of industrial plants and manufacturing processes, and increased awareness of the many thousands of synthetic agents recently introduced into the environment [115, 127] has led to identification of health concerns related to the routine exposure to potentially toxic agents [115]. Toxic synthetic chemicals routinely "leach out of plastics, carpets, and fabrics into air, rainwater, and food; are present in many creams, soaps, and perfumes with which we adorn our bodies; or emanate from exhaust, cigarette, and combustion fumes" [124]. The sweeping extent of adverse environmental exposure is illustrated by a study recently publicized by CDC: the largest and most comprehensive analysis of toxicant exposure ever performed on humans revealed that within their body, most American adults and children have accumulated numerous potentially toxic chemicals, including several household pesticides as well as phthalates originating from beauty products and soft plastics [30].

Many skeptics of human exposure medicine claim that although certain chemical agents may be problematic in large doses, the usual exposures commonly sustained by individuals in western culture are insignificant and well below tolerable levels. While it is true that isolated exposure to various chemicals may be harmless in minute amounts, recent evidence confirms that the human body is unable to adequately metabolize and eliminate many modern chemicals that are typically acquired through ingestion, inhalation, cutaneous absorption, vertical transmission or absorbed from dental or surgical implants. Repeated exposures result in bioaccumulation or stock-

piling of toxicants within human and fetal tissues with potentially serious sequelae [15, 33, 41, 69, 107, 116, 121, 138, 139].

Studies of various organ systems confirm that xenobiotics (foreign chemicals) can target different tissues with a wide range of possible effects. With increased risk for bladder and gastrointestinal malignancies [61], testicular cancer [1, 44, 125, 148], breast cancer [64, 102, 145], leukemia [74], and other tumors as a result of adverse exposure, it is evident that stockpiling of various toxins is partially responsible for the anticipated 50% increase in cancer announced in the United Nations World Cancer Report [103, 153]. The correlation between exposure to toxicants and adverse brain development, behavioral disorders and intellectual dysfunction confirms that the central nervous system is also sensitive to environmental toxins [65, 66, 142]. Reproductive and immune system function may also be impaired as a result of toxic exposure [7, 49, 59]. The pathophysiological change causing such afflictions may involve direct damage to cells and tissues or chemical modulation of cellular activity in various ways.

Research is underway, for example, on many synthetic agents referred to as 'endocrine disrupting chemicals' (EDCs) which, often at minute levels, mimic or block hormones resulting in the potential disruption of critical biological processes including reproduction, growth and development [5, 11, 12, 17, 34, 48, 49, 88, 114, 126, 127]. Some xenobiotic EDCs (also known as hormone disruptors or 'gender benders') have chemical structures that may be very similar to endogenous hormones and which can act on cell receptors to induce physiological action. Just as endogenous hormones such as estradiol or insulin have metabolic impact at levels of parts per trillion and parts per billion, toxicant EDCs can also exert bioactive influence at exceedingly low concentrations. With evidence of pathological change as a result of adverse exposure, hormone dependent processes such as prenatal development [12, 17, 31], breast development and menarche [17, 36], the menstrual cycle [47], fertility [21], and gonadal function [24] appear to be very sensitive to the impact of EDCs. The development of gynecological afflictions including endometriosis have also been correlated with exposure to EDCs [14, 63, 100, 111]. Furthermore, increasing speculation exists that hormone disruptors may be contributing to the widespread prevalence of endocrine disorders [10, 11, 20, 37, 57, 114] and to secular trends within the population including pubertal age reduction [10, 36, 37, 114].

Exposure to various toxicants, including EDCs, often originates from unanticipated sources. Many common foods and fluids, for example, now contain a variety of toxins including pesticide residue, antibiotics, heavy metals, hormones and industrial chemicals [22, 25, 26, 53, 60, 107, 112, 149]. A recent study of commercial baby-food preparations from supermarkets in America discovered that dioxins (potent disruptors of estrogen metabolism) were regularly present in ordinary bottled infant food [122]. Harmful substances called phthalates, known to cause developmental and reproductive toxicity in animals, have even been found within neonatal intensive care infants who were exposed to medical products made with polyvinylchloride (PVC) plastic – including intravenous fluids from plastic bags delivered through plastic tubing [58].

Recent medical literature also confirms that exposure to pharmaceutically active compounds may originate from the residue of medical therapy that is routinely discharged into the environment [39, 62]. Many tons of pharmaceuticals consumed annually by the population are excreted unchanged or through metabolites into water systems [62, 106, 133]. This emerging health and environmental concern is intensified as some chemical residue, including estrogen from oral contraceptives and hormone replacement therapy, may not be completely removed by waste-water treatment plants [114, 126, 134, 135, 157]. Accordingly, various chemical agents, including hormones used in birth control pills "have been shown to be present in the aquatic environment" [62]. While the effects on humans are yet unconfirmed, pharmaceutical and other chemical residue have been correlated with a variety of adverse effects such as the feminization or demise of exposed animal species [16, 23, 85, 86, 123, 126, 136, 140, 150].

Prenatal exposure to toxicants

A review of the recent literature exploring the environmental and toxicological implications of chemical exposure on fetal development brings attention to the critical role of proactive prenatal and preconception care. With hepatic immaturity, a permeable blood-brain barrier, limited plasma components to bind absorbed toxicants, and an inability to adequately excrete various chemical compounds, agents "tolerated by the mother can damage the rapidly growing tissues of her child" [42]. The extent of fetal exposure to toxicants was highlighted by the recent release of study results disclosing toxicant levels in umbilical cord-blood samples taken by the American Red Cross: on average, 287 synthetic chemicals (including mercury, gasoline byproducts, fire retardants, pesticides, and perfluorooctanoic acids from Teflon) were found per sample [46]. The potential sequelae of exposing the developing fetus to chemical toxicants are becoming increasingly evident. A paper published in the *Journal of the American Medical Association* concluded that offspring of women exposed to organic solvents in their occupations (as often occurs in common industries such as laboratory work, cosmetic manufacturing, dry-cleaning, printing, and automotive work) experienced a 13-fold increase in the occurrence of major congenital malfor-

mations including cardiac, genital and central nervous system anomalies [70]. A landmark study recently published in the *Journal of Epidemiology and Community Health* explored a potential correlation between the birth addresses for victims of lethal childhood malignancy and the location of high atmospheric emissions of various chemical agents. The findings suggest that most cancer and leukemia in children results from prenatal exposure to environmental toxins including carbon monoxide from engine exhausts and certain industrial compounds [74]. Numerous other studies have linked prenatal exposure to chemical agents with subsequent morbidity in the offspring (Table 2).

Exposure to diesel exhaust in pregnancy, for example, has recently been associated with asthma in offspring [91], antibiotic exposure *in-utero* has been correlated with increased potential for childhood asthma, allergies and eczema [67, 87], and maternal diuretic use dramatically increases the risk for schizophrenia in progeny [128]. As well as physical damage, a number of publications have expressed concern that exposure to 'gender benders' during critical periods of gestation may subsequently affect sexual function and gender indices in the offspring [10, 35, 43, 90, 107, 116, 120, 130, 131]. When one considers the financial, emotional and personal expenditure associated with caring for childhood malignancy, respiratory problems, and other sequelae of toxic exposure in pregnancy, the profound advantage of precluding such afflictions by simple avoidance of toxins is apparent.

A recent article in *Science* which reports on innovative research about the potential transgenerational impact of exposure to environmental toxins in pregnancy [4] has brought new intensity to concerns about the sequelae of adverse toxicity. After researchers exposed pregnant animals to endocrine disruptors found in common fungicides and pesticides, alterations in fertility as a result of epigenetic changes were noted in offspring, changes which then persisted through all four successive generations examined [4]. In epigenetic transmission, the DNA sequences of the genes remain the same, but chemical modifications alter biological functioning and thus change the way that genes work. (Chemical components become attached to the DNA but are not encoded in the DNA sequence and do not cause genetic mutation.) This appears to be the first multigenerational effect of an environmental toxin identified and the first indication that epigenetic mechanisms may permanently alter the germ-line and genetic traits of subsequent generations of an exposed individual.

Table 2 Examples of prenatal toxic exposure and potential health sequelae.

Prenatal exposure	Possible source	Potential health sequelae	Reference
Carbon monoxide	Industry emission	Pediatric cancer	Knox 2005 [74]
Polyaromatic hydrocarbons	Diesel exhaust	Asthma	Miller 2004 [91]
Electromagnetic fields	Power lines, Transformers Various machines	Pregnancy loss	Li 2002 [78]
Diuretics	Prescription	Schizophrenia	Sorensen 2003 [128]
Psychotropic drugs	Prescription	Impaired psychomotor development	Mortensen 2003 [93]
Antibiotics	Prescription	Asthma & Allergies	McKeever 2002 [87] Johnson 2003 [67]
Organohalogens	Contaminated food	Altered puberty	Blanck 2000 [17]
Phthaltes	Plastic outgas Industrial chemicals Adhesives	Hypospadius Preterm birth	Steinhardt 2004 [130] Latini 2003 [77]
PCBs (Polychlorinated biphenyls)	Contaminated food	Middle ear disease	Chao 1997 [31]
Estrogen	Exogenous intake during gestation (e.g. oral contraceptives)	Testicular cancer	Weir 2000 [148]
DES (Diethylstilbestrol)	Prescription	Genital abnormalities Psychological concerns Reproductive tract cancer	Saunders 1988 [120]
Mercury	Contaminated fish Maternal amalgam	Neurological defects	Gilbertson 2004 [56]
DDT metabolite	Pesticide spray	Preterm birth Small for gestational age	Longnecker 2001 [80]
Dioxins	Contaminated food Pesticide exposure	Behavioral alterations	Vreugdenhil 2002 [142]
Organic solvents	Workplace exposure	Major congenital malformations	Khattak 1999 [70]

In addition to the multitude of chemical toxins that may impact human health, other environmental exposures in pregnancy are becoming the subject of increasing scrutiny. Researchers from WHO, the National Institute of Health, the National Cancer Institute, as well as numerous scientists involved in epidemiology and environmental medicine have recently drawn attention to alleged health risks associated with routine exposure to non-ionizing radiation from electromagnetic fields (EMF) [97, 110, 146]. The magnetic fields emanating from power lines, transformers, as well as certain electrical devices have been the subject of much attention and controversy. A large prospective cohort study recently published in *Epidemiology* reported that rates of pregnancy loss grew significantly with increasing levels of maximum magnetic field exposure in routine day-to-day life [79]. Recent data also suggest that significant EMF exposure may be associated with such wide-ranging conditions as leukemia, suicidal depression, certain cancers, and amyotrophic lateral sclerosis [2, 71, 72, 97, 141, 146]. Results reported in the medical literature on the health risks of EMF exposure, however, are not consistent suggesting that further study is warranted before definitive conclusions and recommendations can be made about exposure to non-ionizing radiation and associated health concerns.

Medical response to environmental health issues

A brief venture into the history of Obstetrics reveals that many post-partum women of the mid-nineteenth century paid with their lives because of a sluggish response to evidence that infection in the form of 'cadaveric particles' was being transmitted to pregnant women by medical staff within hospitals [92, 129]. When a Hungarian Obstetrician, Dr. Ignaz Philip Semmelweis, introduced a simple hand washing protocol, the medical community was reluctant to investigate the evidence and, like many other examples in medical history, several years passed before this community achieved consensus and new protocols were implemented. With increasing evidence correlating environmental toxicity with illness, how efficiently has the contemporary medical and public health community responded?

As a result of increasing concern about environmental influences on health, 'Human Exposure Assessment' [101], the investigation and study of specific patient exposures and related health concerns, is becoming a rapidly expanding area of medical research, but one that generally goes unnoticed in mainstream medicine [50, 55, 83, 101, 104]. Many people are not aware of the significance of environmental medicine because the impact of low level exposure is usually not immediately apparent; toxins may accumulate for many years before adverse outcomes occur and thus the toxicant-sequelae correlation may remain unrecognized by caregivers [124]. As well, the field of environmental medicine has not been a focus for medical training and continuing medical education [89] and many medical schools still do not have any required time in their curricula for this branch of medicine [50]. Consequently, environmental history-taking for common medical problems occurs infrequently in everyday clinical practice [73, 84]. Furthermore, while some physicians are not aware of this emerging branch of healthcare, others dismiss environmental medicine as irrelevant to their practices. Accordingly, the underlying etiology of illness is frequently unexplored [52], leaving many patients to suffer unnecessarily and medicated to mitigate symptoms.

Safety levels and exposure to toxic agents

Many individuals assume that there is a list of widely accepted reference values for all the various toxic agents: values which designate the level of exposure where risk becomes significant. By inference, chemical exposure below this threshold limit is thought to be safe. There are more than a few difficulties with this assumption.

An 'innocent until proven guilty' approach is currently in effect whereby testing to confirm environmental and health safety prior to approval and use of potentially toxic chemical agents, including recognized EDCs, is not yet required [114]; accordingly, the vast majority of synthetic chemical agents in daily use have not been subjected to toxicity testing in order to assign threshold limits for damage. Furthermore, as is the case with the issue of incremental human bioaccumulation of an assorted collection of varied chemical agents, there is little scientific research on the cumulative and synergistic impact of chemical cocktails on the human organism. With the recognition that "two or more compounds may show additive, antagonistic, or synergistic interactions" [27], the permutations of chemistry that take place when mercury, ethinyl estradiol, dioxins, PBDEs, perchlorates, and other agents combine among themselves and then interact with inherent human biochemistry is an overall mystery.

There is also concern about the database of existing threshold limits for those specific toxicants known to have harmful impact as well as considerable unease about the mechanism used to establish these limits [28, 29, 158]. Accepted reference values often reflect those measurements for which no recognized and observable adverse effect is immediately apparent in animal models ('no observable effect level' or NOEL). Human sensitivity to toxicants, however, may occur at substantially lower levels than animal susceptibility – recent genome work has revealed that rodents commonly utilized for research purposes possess genes adept at inducing detoxification mechanisms, genes which are not present in the human [108]. Furthermore, short-term observation can be

deceiving – the diethylstilbestrol (DES) tragedy illustrates that a long time lag may occur before sequelae are evident [120]. The fact that data from animal trials are not necessarily transferable to humans, that long-term manifestations of toxicity are often unrecognized, that bioaccumulation is disregarded, that substantial variation exists in susceptibility to toxicants, that fetal propensity for toxicant uptake is often ignored and that vested interests often influence the process of determining reference levels, are some of the reasons prompting individuals and groups to object to current NOEL levels and to conclude that existing toxicology testing has several fundamental flaws.

After reviewing data related to mercury neurotoxicity and neurodevelopmental risk in children, for example, the EPA proposed a reference dose for methyl mercury that is significantly lower than previous guidelines from WHO, the US Agency for Toxic Substances and Disease Registry, and the US Food and Drug Administration [40]. Similarly, *Environmental Health Perspectives* recently announced the publication of a study showing that unexpectedly low level exposure to PCBs, certain pesticides, and mercury, can interfere with endocrine function during gestation; thus demonstrating that reference levels for adults may differ from limits for developing children [132]. Upon reviewing the mechanism to assign reference values for toxicants, a noted author on environmental health issues, Dr. Grace Ziem, commented that the development process for assigning threshold levels "has been gravely flawed by lack of scientific rigor, inadequate medical input, and lack of attention to financial conflicts of interest" [158].

Quo vadis

Some medical practitioners are reluctant to acknowledge the mounting concerns relating chemical exposures to adverse health outcomes because of conflicting claims found in research studies. Although there is a lack of complete consistency in the research thus far, increasing evidence behooves doubters to re-evaluate the evidence linking common chemical exposures to illness. A number of reasons have been proposed for the alleged disparity in study results including the following: a) most of the research is carried out by the chemical industry and is proprietary – it is suspected that unfavorable studies are often discontinued; b) because of danger to exposed individuals, it is unethical to perform controlled clinical trials to conclusively establish a correlation; c) published conclusions from animal models may not apply to humans; and, d) occupational toxicant research is plagued by selection bias often referred to as "healthy worker effect" [117]. (As chemically sensitive individuals often self-select themselves out of studies because they experience symptoms and consequently resign, remaining employees are not a representative sample and thus compromise the validity of research data.)

Despite the many challenges with previous research, the recent body of case-control investigations, prospective cohort studies, and other research work continues to expose a compelling link between toxicants and eroding health, a link that demands a judicious response from the medical profession. Five recommendations are provided for consideration.

Medical education

As the medical community has been charged with preserving the health of the population, it is essential that physicians take an active role in issues related to human exposure; innovative measures to preserve the well-being of individual patients as well as public health should be considered and implemented [54]. In order to do this, however, doctors need to be adequately educated about issues related to toxicant exposure. Various medical organizations, such as the Ontario College of Family Physicians [99] and general medical journals including the *Canadian Medical Association Journal* [147] have been at the forefront of educating the general medical community about environmental health issues; other specialty divisions, and medical publications should consider their role in this regard.

Clinical practice patterns

From an individual clinical practice perspective, it is important for practitioners to consistently look for etiology of disease rather than focusing predominantly on therapeutics to mitigate signs and symptoms [54]. The scientific literature confirms that by utilizing basic instruments for clinical assessment of adverse environmental exposure [50, 83], by implementing precautionary avoidance education in clinical practice [55, 147, 151], and by aggressively managing patients with evidence of toxic exposure [109], much affliction and illness can be avoided or overcome.

Public education and safety

As advocates for public health and community safety, physicians should be involved in education regarding precautionary avoidance, whereby all necessary means are undertaken to educate the public about precautions to avoid exposure to potentially dangerous toxicants. Preconception programs offered for individual patients and the community may avert numerous congenital abnormalities and preclude various obstetric complications [3, 8, 51, 144]. Furthermore, public policy relating to testing, safety approval, and regulation of chemical agents needs to be re-evaluated and requires vigilant medical input. The public health benefits, the diminished suffering of individual patients and their families, and the

prospective economic advantage to public health care systems [9] are sound reasons to allocate increased attention to this emerging area of community healthcare.

Availability of toxicant testing

With the multiplicity of potential exposures (as evidenced by the recent CDC report [30]), testing for the 'total load' or 'body burden' of toxicants is required as a primary step in the investigation and management of human exposure problems. Many countries including Canada, however, do not yet have testing for toxic chemicals readily available to physicians. Without laboratory testing and the information that it provides, evidence-based medical decisions cannot be made. Furthermore, without identifying the toxicants, research cannot advance and the outcome of therapy to treat toxicant exposure cannot be verified. In accordance with elementary principles of science and evidence-based medicine, health service administrators should make toxicant testing available to trained practitioners.

Medical research

It is also becoming apparent that toxic chemicals are likely a largely unaccounted for and unrecognized confounding factor in ongoing medical and public health research. When assessing the impact of an intervention in a clinical trial, for example, individual differences in toxicant levels – due to location, lifestyle or dietary practices that may exist in culturally or geographically distinct individuals and groups – may significantly affect the response. Ongoing public health research on interventions such as fish consumption, for example, may be marred by varying levels of bioactive contaminants routinely found in tainted seafood [99, 119]. Accordingly, it is important that medical researchers become cognizant of and adept at dealing with adverse exposure concerns as well as having the facility to measure and incorporate levels of chemical toxicants when doing research.

Conclusion

There is compelling evidence that we live in an era of toxicity and that existing environmental regulations have fallen short in adequately protecting human health. As a result, we are the first generation of humankind to be affronted by exposure to many unsafe toxicants that potentially bioaccumulate in tissues of unsuspecting people. The air we breathe, the products we consume, and the milieu in which we exist are having an adverse impact on the lives of many individuals. This realization led to the disquieting observation articulated at the Pediatric Academic Societies' 2001 Annual Meeting: low level exposure to environmental toxicity may be impacting the functioning of the current generation [38]. This realization also provoked the US Congress to recently authorize a National Children's Study "to conduct a national longitudinal study of environmental influences on children's health and development" [137].

Environmental medicine is emerging as a medical discipline of enormous importance to physicians in most specialty areas including specialties that provide healthcare to reproductive age women. In order to diminish the risk of congenital anomalies and to potentially identify and address the etiology of various acute and chronic conditions, it is important that clinicians acquire the skills necessary to elicit an exposure history, develop a familiarity with risk factors for environmental illness, implement proactive education to facilitate prevention, and learn to manage recognized cases of toxicant exposure. Because of the serious potential harm associated with toxicant exposure and the difficulty establishing a cause and effect relationship with each toxicant, it is prudent to recommend a precautionary approach to chemical exposures, particularly during the gestational period.

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