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VIEWPOINT

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On the Need for a National (U.S.) Research Program to Elucidate the Potential Risks to Human Health and the Environment Posed by Contaminants of Emerging Concern

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INTRODUCTION

Research on Contaminants of Emerging Concern (CECs) has produced a large but incomplete patchwork of disconnected studies. We are therefore left underprepared to assess and confront what some believe could be a public and ecological crisis. There are many factors contributing to increased public concern about CECs, including poorly synchronized data, the lack of science knowledge and relative risk among the general public, and the culture of media to highlight negative information. Regardless, the research on CECs does not enable scientists to give sound answers to questions regarding the true risks of CECs in concert with the many stressors influencing human and ecological health, and to propose strategies to prevent or minimize risks.

It is now known that many chemicals have the potential to affect diverse biological function at some dose. While the question, "Is there a public and/or ecological health crisis related to CECs?" is not new, it is not sufficiently being addressed. Studies raise concern by linking specific CECs and biological effects, such as intersex phenotypes in wildlife (e.g., ref 1) or effects in laboratory animals, such as insulin resistance and neurodevelopmental alterations (e.g., ref 2). In addition, exposure to some CECs has been associated with adverse human health effects through epidemiological studies, such as early puberty, declining sperm quantity, and obesity (e.g., 3). There are field studies, however, that did not find predicted effects from CECs alone, presumably as a result of the complex interactions and multiple stressors found in nature (e.g., ref 4). Although there are an increasing number of studies focused on CEC mixtures, temporally variable exposure levels, and non-chemical factors or stressors, it is often difficult to extrapolate these studies. Indeed, when one considers that many studies on CECs are focused on a single chemical/class, a specific mechanism, a specific assay, a single organism, or exposure concentrations that greatly exceed environmentally relevant conditions, it is not surprising that reliable predictive results for complex settings often remain elusive.

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Although much has been learned in the past two decades regarding endocrine-disrupting chemicals and more generally, CECs, many knowledge gaps remain. Which chemicals (including degradation products) are of greatest concern? What are the best approaches for reducing their introduction into the environment and limiting human and ecosystem exposure? What is the extent of the effects of chronic, low-level CEC exposure? What are the relative risks from such exposure compared to nonchemical stressors (e.g., lifestyle and habitat)? What are the major exposure routes for different organisms? What is the interplay of various stressors with CECs, including the role of physical stressors (dissolved oxygen concentration, etc.), and human factors (e.g., stress and diet) as modifiers of CEC effects? Can management of these stressors mitigate the effects of CECs? Transgenerational effects, hormetic responses, differences in sensitivity across species, and the effects of mixtures need research attention. Novel laboratory and field methods and modeling that streamline and expedite identification of hazardous CECs are needed as well.

RESEARCH NEEDS

A National Program Should Be Established to Serve As an Umbrella for Highly Coordinated CEC Research. We know there are adverse outcomes from some chemicals and for some modes of action. The fact that we do not know the full extent and nature of CEC exposure, effects, and interactions is in itself a substantial problem. The goal is to better leverage investments to determine CEC risks, to integrate and synthesize our understanding of how CECs impact ecological and human health, and to determine where effort should be focused to reduce risk. Such a program could serve as an umbrella to coordinate research programs within federal agencies that are studying CECs, as well as create a mechanism to coordinate state/local government, academic, industry, trade association, and nongovernmental organization research efforts. This program would ensure the collaboration of existing national efforts, such as linking CEC research to the place-based National Children's Study centers (http://www.nationalchildrensstudy.gov). It would need a stable and long-term structure to ensure its impact but needs to be flexible to adapt to new knowledge. One program model to consider is the framework used in the National Nanotechnology Initiative (http://www.nano.gov/), a multiagency partnership.

In addition, the following are also needed:

Incorporate Diverse Scientific Expertise into This Initiative, Including the Social and Behavioral Sciences. The success of this program would require not only integrating the already-identified disciplines of environmental chemistry, biology, engineering, epidemiology, and toxicology, but also incorporating research in economics, behavioral science, decision-making science, and public education.

Establish Baselines for Exposures, Effects, and Contaminant Concentrations in a Variety of Locations and Environments. The presence of CECs in the environment has been established, but exposures are not static, and baseline ecological and human health effects (what is "normal") are not known in a variety of environments.

Investigate Effects of Other Nonchemical Agents and Their Interactions with CECs. CEC exposures occur in a larger context. Research needs to focus on the interactions of CECs with other stressors, such as the physical environment, diet, and lifestyle.

SUMMARY

Although numerous government and research organizations in the United States are trying to identify opportunities for collaboration and leveraging study results and plans, there is a general lack of coordination between disciplines that leaves scientists unable to comprehensively answer questions regarding the full impacts of CEC exposures. To enable a science-based approach to understanding this problem before it grows beyond our ability to constrain, we invite the United States government, the public, nongovernmental organizations, and industry leaders to join with scientists in meeting this challenge. In a cause of this magnitude, everyone is a stakeholder.

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