EMERGING ISSUES

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Emerging issues: Nutritional awareness in environmental toxicology

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Abstract

Based on recent evidence, we hypothesize that nutrition can modulate the toxicity of environmental pollutants and thus modulate health and disease outcome associated with chemical insults. For example, certain dietary fats may increase the risk to environmental insult induced by polychlorinated biphenyls (PCBs), and fruits and vegetables, rich in antioxidant and anti-inflammatory nutrients or bioactive compounds, may provide protection. Nutritional awareness in environmental toxicology is critical, because of opportunities to develop dietary guidelines which specifically target exposed populations. Nutrition may provide the most sensible means to develop primary prevention strategies of diseases associated with environmental toxicology.

Nutrition has become a critical issue in medical sciences and in modulation of diseases. Basic and applied research has helped to understand the link between nutrition and the etiology of "modern" age-related diseases such as cardiovascular disease, obesity, diabetes, hypertension, and cancer [1], as well as neurological diseases such as Alzheimer's disease [2] and related dementias. Much evidence suggests that our current trend in overconsumption of highly refined high-fat and high-energy diets, as well as our leading sedentary lifestyles, make us increasingly susceptible to early onset of age-related diseases. Furthermore, the lack of intake of fiber or complex carbohydrates, as well as the lack of consumption of fruits and vegetables rich in antioxidant nutrients and related compounds (such as polyphenolics), can lead to an overall imbalance of our bodies' oxidative stress/antioxidant status [3]. The scientific literature suggests that many age-related diseases are initiated by a lifelong elevated cellular oxidative stress.

In addition to nutrition as it relates to health and disease, one of the emerging issues in modern toxicological sciences is the modification of environmental toxicity by nutrients. Conversely, alterations in the biological or metabolic activity of nutrients by environmental pollutants may be equally important. Humans are increasingly exposed to environmental toxins, mostly as the result of modern industrial development. Furthermore, thousands of hazardous waste sites are scattered among densely populated areas, thus affecting humans either directly or nutritionally through animal and plant food chains. The understanding of environmental toxicity is complex because of the myriad of chemicals and the different pathways that they affect. Recent literature appears to indicate that genetic as well as host factors such as nutrition, overall health, and lifestyle habits can markedly influence the sensitivity or resistance to toxic insults [4−7].

As new paradigms emerge to reflect our understanding of environmental toxicology and health, nutrition has begun to integrate and enhance the thinking within these concepts [8]. There is evidence that poor dietary habits not only make us more susceptible to the onset of age-related diseases but also increases the susceptibility to environmental toxic insults and thus to early disease states. For example, a high intake of linoleic acid in the form of vegetable oils in the average American diet may predispose individuals to inflammatory diseases. This appears to be an important issue, because recent evidence suggests that polychlorinated biphenyls (PCBs) can also induce oxidative stress and inflammation in vascular cells, which are critical events in the pathology of atherosclerosis [7]. Most importantly, proinflammatory dietary fats such as linoleic acid can amplify the vascular toxicity of PCBs. At the same time, antioxidants

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such as vitamin E can markedly block fat-induced and PCB-induced cytotoxicity [9]. This type of emerging knowledge on the interactions between dietary factors and toxicants may lead to the development of new biomarkers for populations near sites of excessive exposure to environmental pollutants such as PCBs [5]. For example, nutritional biomarkers such as plasma vitamin E levels or levels of specific unsaturated fatty acids may reflect both nutritional status and susceptibility to environmental insult that can affect disease risk.

There is a great need to explore further this nutritional paradigm in environmental toxicology to improve our understanding of the relationship among nutrition, exposure to environmental toxins, and disease. Many environmental contaminants exhibit human toxicity and disease through oxidative stress–sensitive signaling pathways. Thus, it is conceivable that nutrients that can contribute to cellular oxidative stress also can exacerbate or amplify environmental toxicity. On the other hand, nutrients that have antioxidant activity could reduce or prevent compromised health or disease induction as a result of exposure to certain environmental pollutants. New technological advances such as "omics" technologies (genomics, toxicogenomics, proteomics, metabolomics, etc.), linked with molecular, cellular, and bioinformatics tools and methodologies should allow the assimilation and interrogation of large data sets and interdisciplinary research opportunities [10−12]. These emerging issues of nutritional biomarkers and new research technologies appear to be of critical significance, because nutrition may be the most sensible means to develop primary prevention strategies of diseases associated with many environmental toxic insults.

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