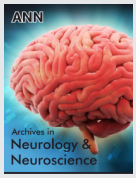

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Review Article

Regulatory Research on New Neurotoxic Pollutants from the Perspective of Biosafety

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Abstract

New neurotoxic pollutants are characterized by persistent organic pollutants (POPs) and endocrine disruptors (EDCs), which are highly concealed, prone to bioaccumulation, and have complex neurotoxicological mechanisms. They can enter the human body through environmental migration and the food chain, interfere with neural signal transduction, induce neuroinflammation and cognitive impairment, and threaten national neurological health and biosecurity. Although China adheres to the approach of "prevention first, systematic governance", the current regulations have flaws such as emphasizing the end and neglecting the source, and fragmented control, making it difficult to effectively block the risk of neuro exposure. This study, from a neuroscience perspective, combined with pollutant migration patterns and neurotoxicity mechanisms, proposes optimized approaches such as strengthening source control, improving full life cycle management, implementing special reviews of chemicals and extended producer responsibility for POPs, EDCs, etc., aiming to build a full-chain legal regulatory system to safeguard biosecurity and public neurological health.

Keywords: Emerging pollutants; Neurotoxicity; Biosafety; Regulatory measures; Systemic governance

Abbreviations: Persistent Organic Pollutants; EDCs: Endocrine disruptors; EPR: Extended producer Responsibility; Eps: Emerging pollutants

Introduction

An emerging pollutant (EPs) is a pollutant that has recently been discovered or is of concern, poses a risk to the environment or human health, and has not yet been managed or is not effectively controlled by existing management measures [1]. Emerging pollutants with neurotoxicity, such as persistent organic pollutants (POPs) and endocrine disruptors (EDCs), have become a common problem for biosecurity in countries due to their long-distance migration, complex mechanisms of action, and accumulation and diffusion along the food chain [2,3]. These new types of neurotoxic pollutants are distinct from naturally occurring neurotoxic substances such as lead and mercury. They are mainly chemical substances directly or indirectly produced by human production and living activities, such as DDT, polychlorinated biphenyls, polycyclic aromatic hydrocarbons in persistent organic pollutants and dioxins, brominated flame retardants and alkylphenols in endocrine disruptors [4,5]. The development of industrial chemistry will constantly generate new neurotoxic pollutants, which pose new challenges to human neurological health and global biosecurity as a whole. From a neuroscience perspective, this paper examines to what extent China's existing measures to prevent new types of neurotoxic pollutants from posing health hazards to humans through environmental media.

The migration and mechanism of action of neurotoxic pollutants

Pollutants containing neurotoxicity can enter the environment through various pathways, such as sewage discharge, atmospheric deposition, etc. [6]. After entering the environment, neurotoxic

pollutants are absorbed directly by the human body or eventually ingested by the human body through the enrichment effect of the food chain and have an impact on the human body [6]. Most neurotoxins damage neuronal communication by binding to ion channels at the presynaptic level, disrupting the permeability of ions such as sodium, potassium, or calcium, inhibiting the release or reuptake of neurotransmitters, or damaging synaptic structures [7]. It may cause an inflammatory response in the human brain, interfere with brain development and accelerate cognitive decline or cause a variety of neurotoxic reactions such as neurotransmitter imbalance and mitochondrial dysfunction [8]. Therefore, measures to prevent and control neurotoxic pollutants are mainly to reduce the amount they are produced and enter the environment, and if they have already entered the environment, to promptly block the way they are ingested by the human body.

The current situation of prevention and control of new neurotoxic pollutants in China

At present, China mainly adopts the principle of "prevention first, systematic governance" for new neurotoxic pollutants, which is in line with the laws of generation, migration, accumulation and governance of new neurotoxic pollutants, but there are still deficiencies in the current prevention and control measures that need to be improved [9]. The current legislation in the field of chemical control in China (such as the Regulations on the Safety Management of Hazardous chemicals) does not fully embody the concept of "full life cycle management", emphasizing the prevention of the intake of new neurotoxic pollutants from the end, but neglecting the prevention of the generation of such chemicals from the source of industrial production and human life. There are specific controls for a particular type of pollutant, but there are loopholes in the treatment of other types of emerging pollutants [10]. This situation does not effectively prevent the long-distance migration of new types of neurotoxic pollutants represented by POPs and EDCs in the environment, and poses significant risks to the health of the human nervous system and the overall biological environment.

Thoughts on improving measures from the perspective of neuroscience

The prevention and treatment of novel neurotoxic pollutants must conform to the objective laws of neuroscience, and specific measures should be developed based on the chemical characteristics of these substances and their mechanisms of action on the human body. Persistent organic pollutants show strong resistance to decomposition in biological, chemical or photochemical processes and can accumulate in adipose tissue and eventually cause neurological dysfunction [11]. Prevention should be the priority in dealing with such substances, and strict control should be exercised over industrial production and the discharge of untreated wastewater and waste gas. Endocrine disruptors affect hormone synthesis or receptor binding by altering hormonal homeostasis in the endocrine system and have been considered to cause mental, cognitive and behavioral disorders in recent studies [12]. Special reviews should be conducted on the endocrine-disrupting effects of new chemicals and the extended producer Responsibility (EPR) system should be strengthened.

Conclusion

This study shows that novel neurotoxic pollutants, represented by persistent organic pollutants and endocrine disruptors, can damage the human nervous system through environmental migration and food chain accumulation, threatening public health and biosecurity. China's current prevention and control measures are mainly end-of-pipe treatment, with insufficient source control and fragmented regulation, making it difficult to adapt to the scientific characteristics of irreversible and highly concealed nerve damage. From the perspective of neuroscience, prevention and control must adhere to the principles of source prevention, precise control, and early blocking. China should improve the management of the entire life cycle, strengthen the special review of high-risk substances, and establish a full-chain legal regulatory system to effectively ensure biosecurity and the neurological health of the people.

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Conflict of Interest

No Conflict of interest.

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