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Review Article

A One Health Approach to Mitigating Acute Pesticide Poisoning in Animals

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ABSTRACT

This overview highlights the importance of adopting a one health approach to tackle the challenges associated with acute pesticide poisoning in animals. The interconnectedness of human, animal, and environmental health underscores the need of collaborative efforts. Swift veterinary care is crucial for immediate intervention, while ongoing monitoring and reporting help identify emerging threats and potential human health risks. This approach emphasizes a unified effort across disciplines to monitor, assess, regulate, educate, and respond to pesticide-related incidents. Surveillance and monitoring systems are foundational to this approach, amalgamating veterinary and human health data to discern trends and potential cross-species exposures. Emergency response plans are integral, ensuring coordinated efforts between veterinary and human health professionals in the event of pesticide poisoning incidents. Data sharing mechanisms and enhanced communication channels foster rapid response and information dissemination. Environmental conservation practices, such as habitat protection and sustainable agriculture, contribute to safeguarding ecosystems from pesticide-related harm. Community engagement is pivotal, encouraging local participation in surveillance and empowering communities to influence decisions regarding pesticide use. By fostering collaboration, promoting awareness, and integrating various expertise, this approach strives to protect the health of humans, animals, and the environment in the face of pesticide-related challenges.

Keywords: *One health, Surveillance, Pesticide.*

INTRODUCTION

In recent years, pesticides' detrimental effects on human and animal health have become increasingly apparent. Acute pesticide poisoning in animals poses significant challenges to environmental sustainability, agricultural productivity, and public health.

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Adopting a One Health approach, which recognizes the interconnectedness of human, animal, and environmental health, is imperative for effectively mitigating the risks associated with pesticide exposure. This article explores the principles of the One Health approach and its application in addressing acute pesticide poisoning in animals. Animal illnesses have alerted the medical community to toxicological disasters, often well in advance of the appearance of adverse health effects in humans (NRC (U.S. National Research Council), 1991).

Unfortunately, however, unnecessary chemically induced diseases remain commonplace today around the world. Direct poisonings involve all body systems, cause acute and chronic dysfunction and often induce lesions, malformations and death. When the immune system is directly involved – as in the case of many heavy metals and mycotoxins – or when it is indirectly involved – as in the case of toxicants that stress animals to prompt the chronic release of cortisol, the risks of infectious diseases increase (Beasley, 2009). Swift veterinary care is crucial for immediate intervention, while ongoing monitoring and reporting help identify emerging threats and potential human health risks.

Acute pesticide poisoning in animals

Acute pesticide poisoning occurs when animals are exposed to toxic chemicals commonly used in agriculture, pest control, and household products. The symptoms of poisoning can vary depending on the type of pesticide and the species affected. Common signs include respiratory distress, neurological symptoms, gastrointestinal upset, and dermatological reactions. Domestic animals such as pets and livestock are particularly vulnerable to pesticide exposure due to their proximity to treated areas and the potential for accidental ingestion. In this context, a One Health approach integrates surveillance, assessment, intervention, and education efforts to mitigate acute pesticide poisoning in animals. By fostering collaboration between environmental agencies, veterinary professionals, agricultural stakeholders, and public health authorities, this approach aims to identify high-risk areas, monitor pesticide usage, assess its impact on wildlife, and implement measures to minimize risks and promote safer alternatives.

Pesticides are a group of chemicals used predominantly in agriculture and against vectors in vector borne diseases such as malaria, filariasis, etc. There are several definitions of a pesticide; the Food and Agriculture Organization of the United Nations (FAO) (Food and Agriculture Organization of the United Nations 1986) defines a pesticide as any substance or mixture of substances intended for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage or marketing of food, agricultural commodities, wood and wood products or animal feedstuffs or which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies. The term includes substances intended for use as a plant-growth regulator, defoliant, desiccant or fruit-thinning agent or agent for preventing the premature fall of fruit and substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport (Jeyaratnam, 1990). Benzine hexachloride is a more common pesticide used in India because it is highly ionic to pests, which was banned by DA&FW in 2022.

Type of Pesticide	Description
Insecticides	Designed to control insects, including ants, mosquitoes, flies, beetles, and caterpillars. Common examples include organophosphates, carbamates, pyrethroids, and neonicotinoids.
Herbicides	Targeted at controlling unwanted vegetation such as weeds, grasses, and brush. Examples include glyphosate, 2,4-D, atrazine, and paraquat.
Fungicides	Used to prevent or eradicate fungal diseases in plants. They are commonly applied to crops susceptible to mold, mildew, and other fungal infections. Examples include mancozeb, chlorothalonil, and captan.
Rodenticides	Rodenticides are designed to control rodents such as rats and mice. They are formulated to attract and kill rodents through ingestion. Examples include anticoagulants (warfarin, brodifacoum) and non-anticoagulants (bromethalin, zinc phosphide).
Nematicides	Target nematodes are microscopic worms that can damage plant roots and affect crop yields. Common examples include organophosphates, carbamates, and bio-based nematicides.
Acaricides	They are specifically designed to control mites and ticks, which can infest plants, animals, and structures. Examples include abamectin, bifenazate, and fenpyroximate.
Molluscicides	They are used to control snails and slugs, which can damage crops and gardens. Examples include metaldehyde, iron phosphate, and copper sulfate.
Avicides	Aimed at controlling birds in agricultural or aviation settings to prevent bird strikes. Examples include 4-aminopyridine, alphachloralose, and avitrol.
Larvicides	They are targeted at killing insect larvae, especially those of mosquitoes and other disease vectors. Common larvicides include Bacillus thuringiensis (Bt), methoprene, and temephos.
Repellents	Repel pests rather than killing them. Examples include DEET (used against insects), capsaicin (used against mammals), and ammonium soaps (used against birds)
Growth regulators	Mimic the hormones of insects or disrupt their growth and development, leading to sterility or death. Examples include insect growth regulators (IGRs) and juvenile hormone analogs.

Type of symptoms in animals

Type of Symptom	Description
Neurological Effects	Symptoms include tremors, convulsions, seizures, ataxia (loss of coordination), hyperactivity, lethargy, and paralysis. Neurotoxic pesticides such as organophosphates and carbamates commonly induce these effects by disrupting nerve signaling.
Respiratory Effects	Pesticide inhalation or ingestion can lead to respiratory distress, difficulty breathing, coughing, wheezing, and pulmonary edema (fluid accumulation in the lungs). Some pesticides, such as organophosphates and fumigants, can cause acute respiratory toxicity.
Gastrointestinal Effects	Following pesticide exposure, animals may exhibit vomiting, diarrhea, abdominal pain, excessive salivation, and drooling. Ingestion of certain pesticides, such as organophosphates, carbamates, and rodenticides, can lead to gastrointestinal irritation and damage.
Dermatological Effects	Skin contact with pesticides may cause irritation, redness, itching, inflammation, blisters, and chemical burns. Animals may develop dermatitis, eczema, or allergic reactions upon exposure to certain pesticides, particularly those with dermal toxicity.
Ocular Effects	Eye irritation, redness, tearing, discharge, and corneal damage can result from direct contact with pesticides or exposure to pesticide fumes. Some pesticides are highly irritating to the eyes and can cause severe damage if not promptly rinsed or flushed.
Reproductive Effects	Pesticide exposure may lead to reproductive disorders, infertility, embryotoxicity, fetal malformations, and developmental abnormalities in offspring. Endocrine-disrupting pesticides, such as organochlorines and glyphosate, are of particular concern for their potential to interfere with reproductive processes.
Hematological Effects	Pesticides can disrupt blood cell production, leading to anaemia, hemolysis (breakdown of red blood cells), thrombocytopenia (low platelet count), and coagulopathy (bleeding disorders). Some pesticides, such as anticoagulant rodenticides, directly interfere with blood clotting mechanisms.

Hepatic and Renal Effects	Certain pesticides, including organophosphates, chlorinated hydrocarbons, and heavy metals, can cause hepatotoxicity (liver damage) and nephrotoxicity (kidney damage) in animals. Symptoms may include jaundice, hepatic encephalopathy, uremia, and renal failure.
Immunological Effects	Pesticide exposure may suppress or dysregulate the immune system, increasing susceptibility to infections, allergies, autoimmune diseases, and neoplastic disorders. Immunotoxin pesticides include organochlorines, organophosphates, and pyrethroids.

Creating a comprehensive chart of antidotes for pesticide poisoning is challenging because antidotes vary depending on the specific pesticide involved and the severity of the poisoning. Moreover, many pesticides do not have specific antidotes, and treatment often focuses on supportive care and symptomatic management.

Type of Pesticide	**Antidote**
Organophosphates	Atropine (for muscarinic effects), pralidoxime (2-PAM)
Carbamates	Atropine (for muscarinic effects)
Cyanide compounds	Sodium thiosulfate, hydroxocobalamin, amyl nitrite
Anticoagulant rodenticides	Vitamin K1 (phytomenadione)
Metal phosphides	Hydrogen peroxide (for aluminum and magnesium phosphide), copper salts (for zinc phosphide)
Pyrethroids	No specific antidote; supportive care
Glyphosate	No specific antidote; supportive care
Paraquat	Hydrogen peroxide (for aluminum and magnesium phosphide), copper salts (for zinc phosphide)
2,4-D herbicide	No specific antidote; supportive care
Atrazine	No specific antidote; supportive care
Chlorinated hydrocarbons	No specific antidote; supportive care
Fumigants (e.g., methyl bromide)	No specific antidote; supportive care
Botanical pesticides (e.g., nicotine)	No specific antidote; supportive care

The One Health Approach

The One Health approach emphasizes the interconnectedness of human, animal, and environmental health and advocates for collaborative efforts to address complex health challenges. Key principles of the One Health approach include interdisciplinary collaboration, holistic thinking, and proactive prevention strategies. By recognizing the interdependence of different ecosystems and species, the One Health approach seeks to promote sustainable solutions that benefit both people and the planet. This approach emphasizes a unified effort across disciplines to monitor, assess, regulate, educate, and respond to pesticide-related incidents. Surveillance and monitoring systems are foundational to this approach, amalgamating veterinary and human health data to discern trends and potential cross-species exposures. Integrating One Health Strategies for Mitigating Acute Pesticide Poisoning

Applying the One Health approach to mitigate acute pesticide poisoning in animals requires a multi-faceted strategy that addresses the root causes of pesticide exposure while promoting environmental stewardship and animal welfare. This includes:

1. **Surveillance and Monitoring:** Establishing surveillance systems to track pesticide use, poisoning incidents, and emerging trends in animal health. This data can inform targeted interventions and regulatory policies to reduce pesticide-related risks.

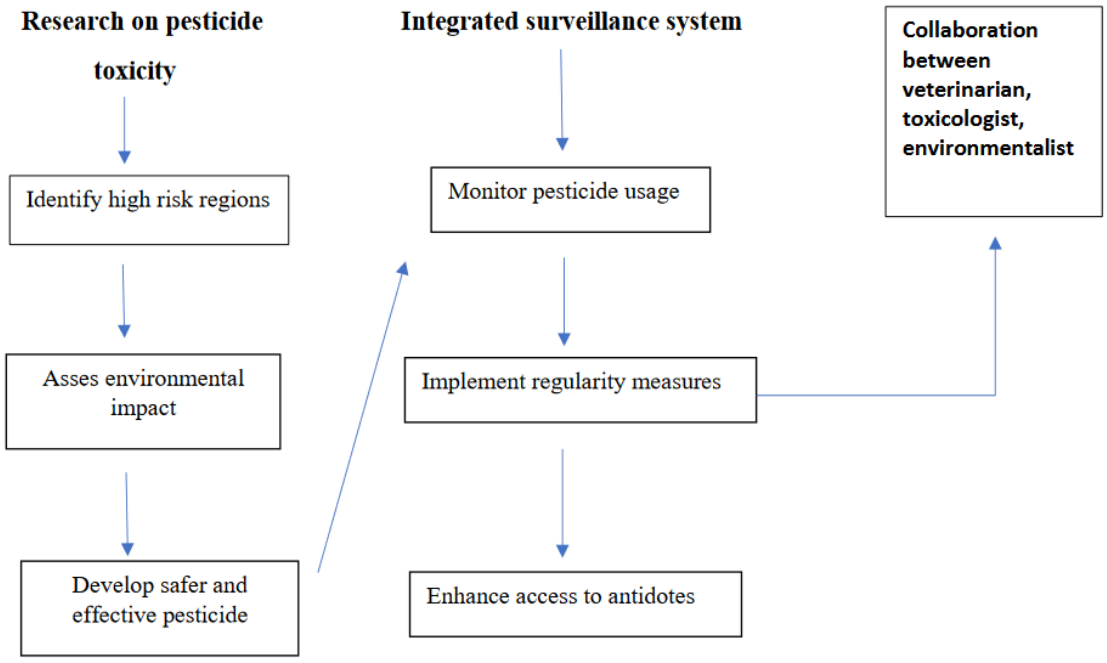
2. Education and Outreach: Raising awareness among farmers, pet owners, veterinarians, and the general public about the hazards of pesticides and the importance of safe handling practices. Providing training on integrated pest management techniques and alternative pest control methods can help reduce reliance on chemical pesticides.

3. Regulatory Oversight: Strengthening regulations governing the sale, use, and

disposal of pesticides to minimize environmental contamination and protect vulnerable species. Implementing pesticide-free buffer zones around sensitive habitats and water sources can help mitigate the risk of exposure to non-target organisms.

4. Veterinary Care and Treatment: Enhancing veterinary capacity to diagnose and treat pesticide poisoning in animals through training programs, diagnostic tools, and access to antidotes and supportive care. Collaboration between human and veterinary healthcare professionals can improve early detection and management of pesticide-related illnesses in both animals and humans.

5. Research and Innovation: Investing in research to develop safer alternatives to conventional pesticides and innovative technologies for pest control. This includes exploring biopesticides, genetically modified crops with built-in pest resistance, and precision agriculture methods that minimize chemical inputs.



Arrow diagram: - Illustrating a One Health approach for mitigating acute pesticide poisoning in animals

Challenges and Opportunities

Challenges and Opportunities While the One Health approach offers a promising framework for mitigating acute pesticide poisoning in animals, there are several challenges that must be addressed to achieve meaningful progress. These include: - Limited Funding and Resources: Securing adequate funding and resources for One Health initiatives, including research, surveillance systems, and capacity-building efforts, remains a persistent challenge. - Data Sharing and Collaboration: Overcoming barriers to data sharing and collaboration between different sectors and disciplines, including agriculture, public health, veterinary medicine, and environmental science. - Policy and Regulatory Barriers: Addressing regulatory gaps and inconsistencies in local, national, and international pesticide management policies. - Socioeconomic Factors: Recognizing the socioeconomic drivers of pesticide use and ensuring that interventions are socially equitable and culturally sensitive.

CIBRC (Central Insecticides Board and Registration Committee) India plays a significant role in pesticide regulation and management, which indirectly affects the prevention and management of pesticide poisoning. Here are some of the key roles and responsibilities of CIBRC in the context of pesticide poisoning

1. Regulation and registration of pesticides.
2. Setting standards and guidelines for pesticide use.
3. Monitoring and surveillance of pesticide residues.
4. Training and capacity building on pesticide safety.
5. Coordination and collaboration with stakeholders in pesticide management.

CONCLUSION

Pesticide poisoning is a major problem in India (Das & Das, 2018). Acute pesticide poisoning in animals significantly threatens global health, biodiversity, and food security. Their massive and indiscriminate use in crop protection, food preservation, and insect pest control has led to acute or chronic poisoning incidents in humans, domestic animals, and wildlife, resulting in widespread ecological adverse effects (Gupta & Gupta, 2019). Adopting a One Health approach offers a comprehensive strategy for mitigating these risks by promoting interdisciplinary collaboration, proactive prevention measures, and sustainable agricultural practices. By working together to address the root causes of pesticide exposure, we can protect the health and well-being of animals, humans, and the environment for generations to come.

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Author Contribution

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