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Neurological manifestations of organophosphate exposure in animals: A one health approach to agrochemical toxicity

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Abstract
The period from February 2022 to July 2023, a total of 1023 neurological cases were documented at Veterinary Clinical Complex, Veterinary College and Research Institute, Orathanadu. Among these, 198 cases were considered to have neurological issues and 32 cases showed signs of delayed Organophosphate poisoning symptoms. The agrochemicals including pesticides and fertilizers has raised significant concerns due to its adverse effects on both environment and human health. This paper aims to provide an overview of the multifaceted problems associated with agrochemical overuse, focusing on acute and delayed organophosphate (OP) poisoning. The use of pesticides and fertilisers in agriculture are responsible for water and soil pollution. It is also caused due to the excessive use of fertilizers in the fields. It acts as a food for algae and the growth will lead to reduce the oxygen content of water and kill many aquatic organisms. Organophosphate pesticides are commonly applied on farms for crop protection. Organophosphates and carbamates are highly toxic to all animals and humans and it can be highly fatal. The main objective of the study was to assess the role of agrochemicals in causing disease to all species and its effect on one health. On one health approach, we demand the interconnectedness of environment, human and animal health, highlighting the need for a comprehensive strategy to mitigate the challenges.

Keywords: Agrochemicals, pesticides, agriculture, Organophosphate poisoning, acetyl choline esterase

Introduction
Organophosphate poisoning is a significant concern in veterinary and human medicine due to its neurotoxic effects. organophosphates and carbamates, commonly used in agriculture for pest control, have been implicated in severe toxicity cases across species. More than 30,000 organophosphate (OP) insecticides have been identified. These compounds are organic esters of phosphoric acid (H_3PO_4) and its derivatives. Examples include Dichlorvos (Nogos, DDVP), an ester of phosphoric acid; Parathion (Agrofos), Methylparathion (Vofatox), and Diazinon, which are derivatives of thiophosphoric acid (H_3PO_3S); and Malathion (Karbofos, Metatox) and Dimethoate (Rogor), which are derived from dithiophosphoric acid [1]. As Organophosphates being most intoxicants for human and animals, it involves major public health risks and these compounds can enter through various routes like ingestion, inhalation, skin and mucous membranes [2, 3]. Specifically, organophosphates exert their toxic effects by inhibiting the enzyme acetylcholinesterase, preventing it from breaking down of acetylcholine. As a result, they are considered the most potent group of anticholinesterase agents [4]. The One Health approach underscores the interconnectedness of human, animal, and environmental health, making it imperative to study the implications of OP poisoning comprehensively.
In cases of chronic organophosphorus toxicity, the outcome often involves OP-induced delayed neuropathy (OPIDN), which is characterized by weakness, lack of coordination, unconsciousness, and primarily affects the pelvic limbs proprioception [5]. Whereas, the acute organophosphate poisoning shows clinical signs like bradycardia, bronchoconstriction, diarrhea, salivation, nasal discharge, apathy, prostration, motor incoordination, head pressing against objects, neck stiffness, paresis, flaccid paralysis of the limbs, permanent decubitus, pedaling movements in lateral decubitus, muscle tremors and death [6].

Materials and Methods

A retrospective study was conducted at Veterinary Clinical Complex, Veterinary College and Research Institute, Orathanadu from February 2022 to July 2023. Neurological cases were identified and a subset of 32 cases with delayed Organophosphate poisoning symptoms was further analyzed. Clinical manifestations, diagnostic approaches and treatment outcomes were recorded. The cases suspected for OP poisoning, serum samples were collected and analyzed for Butyryl cholinesterase (Optimus®) using semi-autoanalyzer (SA-20-CLINDIAG)as per the standard protocol. Butyryl choline esterase acts as the biomarker in detecting and assessing the severity of OP poisoning in animals [7].

Results and Discussion

Out of the 1023 neurological cases, 198 were suspected of having neurological disorders and 32 (47.06 per cent) cases were diagnosed with delayed OP (OPIDN) poisoning. Clinical symptoms included muscle tremors, weakness, respiratory distress, seizures and progressive neurological deterioration (Fig 3). The environmental impact of excessive pesticide use contributes significantly to OP poisoning in animals, as these chemicals persist in water and soil (Fig. 1). Moreover, OP compounds are known to interfere with acetylcholinesterase activity leading to overstimulation of the nervous system. Whereas, the delayed OP poisoning cases showed signs like generalized weakness, emaciation, tetraparesis/plegia, flaccid paralysis, Megaesophagus, urinary incontinence, spastic paralysis and laryngeal paralysis (Fig. 2). The clinical signs were depicted in the form of graph as per the percentage of occurrence (Fig 4). Here, all the cases showing clinical signs similar to OP poisoning showed decline in the level of butyryl cholinesterase below 3400 u/L indicative of OP poisoning (Fig.5). The butyryl cholinesterase acts a early indicator in assessing the degree of OP poisoning [8]. Intermediate syndrome IMS presented as paralysis, occurring 7 to 96 hours post-ACC(Acute Cholinergic crisis), but before the typical onset time of OPIDP. It was clinically characterized by muscular weakness, predominantly of proximal limb muscles, neck flexors, muscles innervated by motor cranial nerves or respiratory muscles [9]. IMS was also characterized by prolonged cholinesterase inhibition [10].

Fig 1: Organophosphate pesticides- Available for farm practices

Agricultural runoff containing pesticides and fertilizers contributes to water and soil pollution, fostering algal blooms that deplete oxygen levels and threaten aquatic life. The overuse of these chemicals not only disrupts ecosystems but also poses a severe risk to humans and animals through direct exposure and food chain contamination. Aluminium phosphide was the principal cause of fatal pesticide poisoning during the initial decade, but its occurrence declined markedly over time. In contrast, organophosphorus insecticides remained significant throughout the study period and emerged as the predominant toxic agents in the later decade. [11].

The One Health perspective emphasizes the need for integrated policies to regulate pesticide use, promote sustainable farming practices and enhance public awareness of OP poisoning risks. Collaborative efforts among veterinarians, medical professionals, environmental scientists and policymakers are essential to mitigating these challenges.

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Conclusion

Organophosphate poisoning remains a critical issue affecting animal, human, and environmental health. Addressing this issue requires a multidisciplinary approach, integrating veterinary and medical knowledge with environmental conservation efforts. Strengthening regulations on pesticide use, adopting sustainable agricultural practices and increasing awareness among farmers and pet owners can help reduce the prevalence and impact of OP poisoning. Whenever we are unaware about the history of poisoning, assessing butyryl cholinesterase will be a diagnostic tool to proceed with further treatment protocol.

Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article.

Fig 2: Delayed OP poisoning showing emaciation and paralysis

Fig 3: OP poisoning in all species showing varied clinical signs

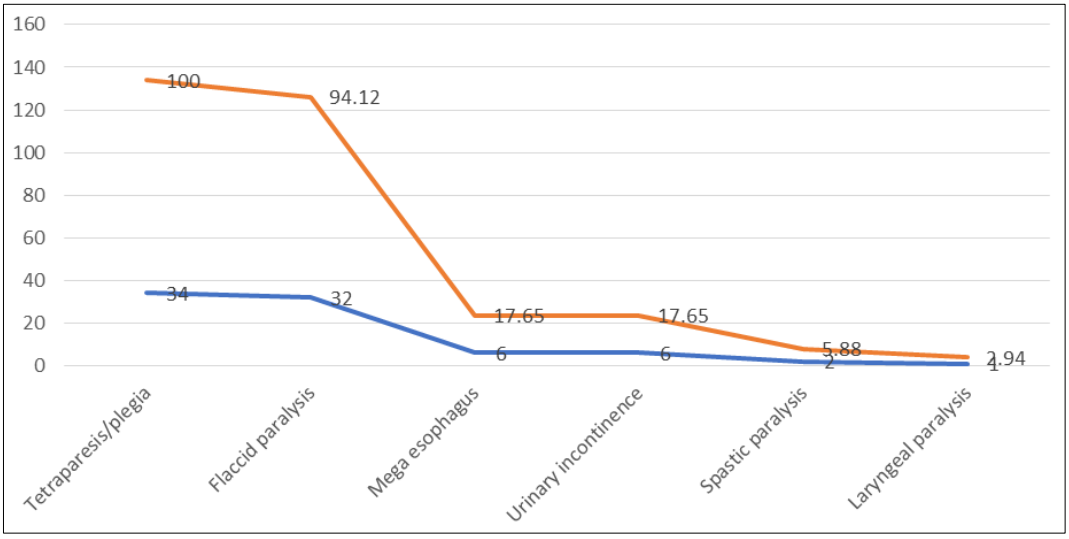

Fig 4: Clinical signs of neuromyopathy in animals

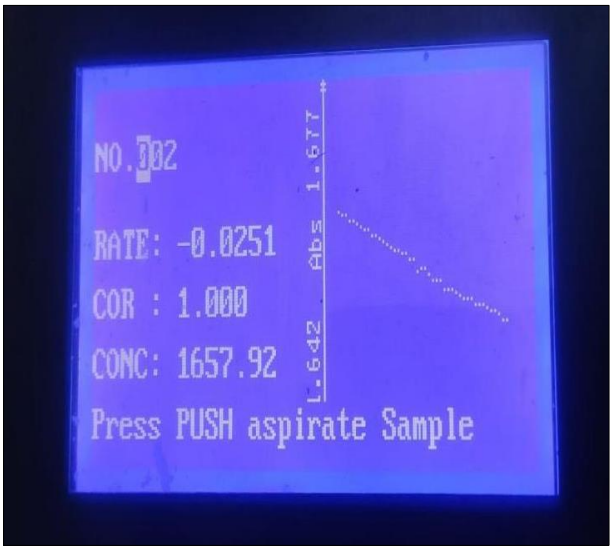

Fig 5: Assessment of Butyryl cholinesterase using semi-autoanalyser (1657.92 u/L)

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