

Organophosphate and Carbamate Poisoning



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KEYWORDS

- Organophosphate • Carbamate • Pesticides • Insecticides • Nerve agents
- Chemical warfare • Atropine • Oxime

KEY POINTS

- Organophosphates (OPs) and carbamates have a variety of applications, but are primarily used agriculturally as pesticides.
- OPs and carbamates are responsible for the deaths of hundreds of thousands of people every year.
- Acute toxicity results from acetylcholinesterase (AChE) enzyme inhibition and subsequent excessive nicotinic and muscarinic stimulation in the central and autonomic nervous systems and the neuromuscular junction.
- Good supportive care, decontamination, aggressive antimuscarinic therapy, early seizure control, and early antidotal oxime therapy are the keys to good outcomes.

INTRODUCTION

Epidemiology

Experts believe that acute poisoning from acetylcholinesterase (AChE)-inhibiting insecticides is responsible for more deaths than any other class of drug or chemical.¹ They are a particular problem in the developing world, where highly toxic pesticides are readily available and are used in the suicides of hundreds of thousands of people every year.² With an estimated case fatality rate of 10% to 20%, the subsequent health care burden of those who do not die after a suicidal ingestion is an order of magnitude higher.^{3,4} The disease burden of OP and carbamate toxicity is much less in developed countries. In contrast with the 25,288 people who committed suicide with pesticides in India in 2010,⁵ the American Association of Poison Control Centers in 2012 received a combined 4150 calls for OP and carbamate exposures, resulting in a total of 3 deaths.⁶ Although unintentional agricultural poisonings do occur, they are generally less severe.^{7,8}

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Uses

Commercially, organophosphorus chemicals have a number of applications, but are mostly employed as pesticides in a variety of settings (**Box 1** from⁹). They protect commercial and food crops from damaging insect vectors. They also control insect infestations in commercial and residential settings. It should be noted that the Environmental Protection Agency has banned or plans to remove many OPs from the United States and thus OP use for many of these applications has been sharply curtailed. Some medical indications for organophosphates (OPs) include the eradication of corporeal insect infestations in humans and animals. One organic phosphorus chemical is used for glaucoma (diisopropyl phosphorofluorodate).

Militarized OPs (also known as nerve agents) are classified as chemical weapons and weapons of mass destruction. Despite the manufacture of hundreds of thousands of tons of these chemicals by various countries during the 20th century, only small amounts have been deployed in a number of clandestine situations, including the Iran–Iraq war, the Iranian attack on the Kurds, and more recently in the Syrian Civil war in August 2013, resulting in more than 1400 deaths.¹⁰ Before this, the most notable use of nerve agents was the 1995 terrorist attack in Tokyo, Japan, which left 11 dead and more than 5000 victims seeking medical attention.¹¹ These recent episodes are tragic reminders of the persistent threat posed by nerve agents.

By volume, carbamates are used most frequently as pesticides. However, they do have number of interesting medical indications (**Table 1**).

History

OPs are of particular historical interest given their development and use as chemical weapons. The early part of the 20th century saw the development of the G-series of nerve agents (tabun, sarin, and soman) by the Germans, the V-series (VE, VG, VM,

Box 1

Sources of organophosphorus pesticides

Domestic

- Garden sheds—in particular insecticidal preparations but also other products that are marketed as fertilizers but contain some organophosphorus pesticides, available as solid or liquid formulations
- Surface and room sprays
- Baits for cockroaches and other insects (eg, chlorpyrifos)
- Shampoos against head lice (eg, malathion)
- Pet preparations (eg, pet washes, collars)

Industrial or occupational

- Crop protection and livestock dipping
- Large scale internal control, including fumigation

Terrorism or warfare (nerve agents)

- Sarin, for example, was used in the Tokyo subway attack, and both tabun and sarin were used during the Iraq–Iran conflict; although nerve agents share a similar mechanism of toxicity with organophosphorus pesticides, their treatment is a specialized topic and not dealt with in this review

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