INTENTIONAL INDOOR-AIR POLLUTION - PESTICIDES

Janette D. Sherman

Alexandria, Virginia, USA

ABSTRACT

Serious, irreversible harm has been documented in 106 persons, resulting from household or work-place contamination with two families of pesticides, the organophosphates (OPO4) and the chlorinated-cyclodienes (Cl-CD), the latter represented by chlordane/ heptachlor (C/H). All of the cases were evaluated in the context of medical-legal proceedings. A plea to stop the interior use of pesticides is made, supported by review of the physical and economic burdens suffered by these representative persons, and by the literature.

INTRODUCTION

Illnesses arising from the intentional use of pesticides is recognized with increase in severity and occurrence. Contributing to the problem is aggressive advertising, urging the use of pesticides to control relatively innocuous pests; lack of teaching and knowledge about alternative, less hazardous methods of pest control; use of persistent and toxic chemical products; and use within buildings with poor-to-no outside ventilation.

BACKGROUND

The organophosphate pesticides (OPO4) were developed in Germany, during World War II (1). These first products included TEPP (tetraethyl pyrophosphate), developed as a nicotine substitute, followed by Tabun and Sarin, the chemical "nerve agents", employed in warfare. The neurotoxicity of the OPO4 chemicals, which include the war agents and the commonly employed products, chlorpyrifos and diazinon are well documented (2,3).

The chlorinated cyclodiene (Cl-CD) pesticides, chlordane and heptachlor (C/H), were developed in the mid-1940s as successors to DDT. Although early reports of volatility, fat solubility and persistence (4,5,6) were reported, use and toxic effects became common (7). Cancellation of chlordane/ heptachlor was recommended by a USA Governmental Commission as early as 1969 (8), but it wasn't until 1987, that the only manufacturer, Velsicol Corporation suspended sale of chlordane in the USA. Although reports of carcinogenicity (9,10,11), immunotoxicity (12), liver toxicity (13) and neurotoxicity (14) support cancellation of these products, manufacture in the USA and sales over-seas continues (15).

OPO4 and Cl-CD pesticides that are fat-soluble are absorbable though the intact skin and can be expected to exert prolonged effects. They have the potential to bioaccumulate and biomagnify, as in breast milk. Most of the water-insoluble pesticides are distributed in an organic solvent base (such as xylene) and/or with an emulsifying agent, which adds the toxicity of the carrier chemical(s), and increases uptake of the primary pesticide.

Exposure to OPO4 products, whether used as war agents or as pesticides, results in predictable toxic effects, due to neurotransmitter interference. OPO4 pesticides inhibit cholinesterase, the enzyme that reverses the breakdown of acetylcholine, thus allowing accumulation of acetylcholine and un-reversed stimulation of nerve tissue and effector organs. Effects may be produced by multiple small doses, resulting in signs and symptoms comparable to a single larger exposure, as expressed in the three main divisions of the nervous system.

The muscarinic nerve receptors, located in the postganglionic parasympathetic nerve endings, are found primarily in smooth muscle, the heart and endocrine glands. Stimulation results in wheezing, nausea, vomiting, abdominal cramps, frequent and/or involuntary defecation and urination, and visual disturbance.

The nicotinic receptors are located in the autonomic ganglia and at the endings of skeletal muscle nerves. Stimulation results in weakness, fatigue, muscle cramps, and involuntary muscle twitching and fasciculation. Weakness of the muscles of respiration contributes to loss of respiratory efforts and dyspnea. Autonomic effects include rapid heart beat, which may mask the muscarinic bradycardia, increased blood pressure and pallor.

Delayed neurotoxic effects of the nicotinic receptors usually begin in the distal lower limbs with sensory disturbance and motor weakness. Neurological damage may lead to ataxia, increasing weakness, and flaccid paralysis. Some recovery may occur with discontinuation of exposure, but repair is slow and often not complete.

Central nervous system symptoms of acetylcholine accumulation secondary to OP04 exposure include headache, anxiety, confusion, slurred speech, tremors, incoordination, generalized weakness, restlessness, sleep disturbance, nightmares and excessive dreaming, emotional instability, neurosis, apathy, and seizures. The Cl-CD pesticides are neurotoxins, producing similar symptoms.

Exposed persons may display any of the constellation of symptoms, in combination or alone, thus presenting a problem of accurate diagnosis for a physician or health official. Failure to make the connection between a patients' illness and pesticide exposure has serious consequences. Patients have received ineffective (and often harmful) treatment, rather than primary prevention, which is cessation of exposure.

Despite seeking care, only rarely was a diagnosis of OPO4 poisoning made, and even more rarely, were the patients treated with atropine. The same lack of diagnosis occurred in the C/H exposed persons, also without stopping exposure. Costly and ineffective treatments were prescribed, while exposure continued in most cases, as signs and symptoms persisted.

Interior contamination results in a cycle of exposure with carpets furniture and bedding acting as absorbent reservoirs. A major source of exposure, especially for children, is skin contact with contaminated surfaces.

Heat, whether from sunlight or a heating system volatilizes the chemicals, resulting in deposition on colder surfaces, not usually thought of as absorbent, such as the outside of appliances, mirrors, and windows, especially at night. As a room heats up, a new cycle of re-circulation takes place. For this reason, when monitoring is needed, wipe samples are preferable to air samples to determine the reservoir of exposure.

The symptoms caused by pesticide contamination of buildings are added to those resulting from inadequate ventilation and building materials that contain formaldehyde, isocyanates, solvents, plastics and the like, thus increasing illness, and making diagnosis difficult.

SUBJECTS AND RESULTS

Collectively, the OPO4 and the Cl-CD groups were exposed in their homes or work-places as a result of commercial pesticidal treatment, intended to kill fleas, roaches and termites. In most cases there was a delay in diagnosis of pesticide-related illness(es), ranging from weeks to years. Thorough histories, review of medical and exposure records, and environmental and/or biological sampling confirmed exposures.

Table 1.

Patient numbers and symptoms:		OPO4-exposed		Cl-CD exposed	
Ages	0-10	4	4-Male	18	10-Male
	11-20	5	5-M	6	4-M
	21-30	15	9-M	14	7-M
	31-40	5	0-M	17	12-M
	41-older	7	2-M	15	8-M
	Total number	36		70	
Headaches		26	(72%)	46	(66%)
Seizures		6	(17%)	8	(11%)
Peripheral nervous system Sx		17	(47%)	12	(17%)
Eye symptoms		14	(39%)	25	(36%)
Ear, nose and throat symptoms		18	(50%)	30	(43%)
Chest symptoms		24	(67%)	31	(44%)
Skin		7	(19%)	23	(33%)
Nausea/ vomiting		14	(39%)	29	(41%)
Persistent diarrhea		12	(33%)	12	(17%)
Malignancy		2	(5%)	5	(7%)

Thirty persons were exposed to chlorpyrifos, with 8 exposed to chlorpyrifos plus one and two additional products. Three were exposed to diazinon and one to other OPO4 products. Nineteen exposures occurred in the workplace and 17 in the home. Chest congestion persisted in half of those initially affected. 47% initially had nausea, vomiting and/or diarrhea. 25% complained of initial dizziness. Of those with peripheral neuropathy, half have had to stop work because of impairment. Five persons developed permanent bladder and fecal incontinence. Nervous system problems of memory loss, confusion, sleep disturbance, weakness, fatigue and the depression that goes with alteration of ones' previous state of function have had profound adverse effects. This is especially tragic, in that 80% of those affected were 40 years of age or younger, and 22% were 20 or younger with the potential for loss of mentation (16). One child, exposed as an infant has remained essentially quadriplegic. Two additional children have impaired learning.

Of the C/H pesticide exposed group, 31% were under 20 years of age, and 76% were younger than 40. Most exposures occurred in the home, following pesticide application for termite control. Three men worked as pest control operators, and had home exposure as well. Five persons have developed cancer: liver 2; leukemia 1; aplastic anemia 1; lung 1. One child died during a seizure following acute exposure.

The C/H groups' problems included confusion or memory deficit in 30%, and vertigo, anxiety and/or depression in 25%. Other problems included skin rashes and benign tumors in 43%, and hematological abnormalities in 11%. The C/H-exposed children were especially affected: 70% had neurological, neuropsychiatric and/or respiratory complaints. Other prominent problems were gastrointestinal 55%; eye 35%; and hematological 25%.

As noted, OPO4- and Cl-CD-caused illnesses were more pronounced in children, but affected other small household members as well: pet fish, kittens and puppies died. Cats and dogs developed seizures, tremors, as well as cancers, and died. These sentinel events often provide clues to the cause of human disease.

DISCUSSION

The cost of illnesses resulting from exposure to pesticides in the home is great. These costs include those of direct medical care, loss of income, loss of mentation, loss of enjoyment of life, condemnation of building structures, and cost of litigation in many cases. The total number of persons who are symptomatic as a result of exposure to OPO4 and Cl-CD pesticides is unknown. Many of the illnesses mimic those with other causes. In the USA, with no systematic pesticide application registry, only case-by-case reports of persons residing and working in buildings that have been contaminated with pesticides are available.

Marketing of similar products under different trade names, and the promotion of odorless and slow-release encapsulated formulations, makes diagnosis difficult. Unrecognized migration and persistence of indoor pesticide products, even when used according to direction, has resulted in contamination (17,18).

The extensive body of information concerning the OPO4 and Cl-CD pesticides should alert regulatory and public health workers to the hazards of use, especially where interior contamination results. Larger problems of loss of non-target species; development of resistant pest strains; food, soil and water contamination; possible dioxin contamination of chlorpyrifos (19); and world-wide reports of endocrine disruption across multiple species (20) should force radical changes in pesticide production and use.

Alternative and effective methods of pest control have been available for decades, and should be promoted. The interior use of these toxic chemicals should be stopped. Viewed in terms of personal and economic loss, increased medical burdens and costs, and loss of intellectual capacity, demonstrates that hazards far out-weigh benefits.

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