

Health and Safety Guide No. 66

TRICHLORFON HEALTH AND SAFETY GUIDE



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Health and Safety Guide No. 66

**TRICHLORFON
HEALTH AND
SAFETY GUIDE**

This is a companion volume to
Environmental Health Criteria 132: Trichlorfon

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INTRODUCTION

The Environmental Health Criteria (EHC) documents produced by the International Programme on Chemical Safety include an assessment of the effects on the environment and on human health of exposure to a chemical or combination of chemicals, or physical or biological agents. They also provide guidelines for setting exposure limits.

The purpose of a Health and Safety Guide is to facilitate the application of these guidelines in national chemical safety programmes. The first three sections of a Health and Safety Guide highlight the relevant technical information in the corresponding EHC. Section 4 includes advice on preventive and protective measures and emergency action; health workers should be thoroughly familiar with the medical information to ensure that they can act efficiently in an emergency. Within the Guide is a Summary of Chemical Safety Information which should be readily available, and should be clearly explained, to all who could come into contact with the chemical. The section on regulatory information has been extracted from the legal file of the International Register of Potentially Toxic Chemicals (IRPTC) and from other United Nations sources.

The target readership includes occupational health services, those in ministries, governmental agencies, industry, and trade unions who are involved in the safe use of chemicals and the avoidance of environmental health hazards, and those wanting more information on this topic. An attempt has been made to use only terms that will be familiar to the intended user. However, sections 1 and 2 inevitably contain some technical terms. A bibliography has been included for readers who require further background information.

Revision of the information in this Guide will take place in due course, and the eventual aim is to use standardized terminology. Comments on any difficulties encountered in using the Guide would be very helpful and should be addressed to:

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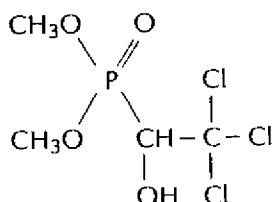
THE INFORMATION IN THIS GUIDE
SHOULD BE CONSIDERED AS A
STARTING POINT TO A COMPREHENSIVE
HEALTH AND SAFETY PROGRAMME

1. PRODUCT IDENTITY AND USES

1.1 Identity

Common name: trichlorfon (ISO)

Chemical structure:



Chemical formula: C₄H₈Cl₃O₄P

Relative molecular mass: 257.44

CAS chemical name: dimethyl 2,2,2-trichloro-1-hydroxyethyl-phosphonate

Synonyms: Chlorofos; DEP; DETF; dipterex; dimethyl 1-hydroxy-2,2,2-trichloroethane-phosphonate; O,O-dimethyl (2,2,2-trichloro-1-hydroxyethyl) phosphonate; metrifonate, foschlor; trichlorofon; trichlorophon

Trade names: Agroforotox; Anthon; L 13/59; Bilarcil; Cekufon; Danex; Dipterex; Ditriphon; Dylox; Dyrex; Dyvon; Masoten; Metrifonate; Neguvon; Proxol; Tugon; Wotex

CAS registry number: 52-68-6

PRODUCT IDENTITY AND USES

RTECS registry number:	TA0700000
Conversion factors:	1 ppm = 11.4 mg/m ³ 1 mg/m ³ = 0.088 ppm, at 25 °C and 101.3 kPa (760 mmHg)

The purity of technical trichlorfon is reported to be more than 98%. It is a racemic mixture of two isomers. The main impurities are 2,2-dichlorovinyl dimethyl phosphate, dichlorvos (0–0.2%), trichloroacetaldehyde (0–0.05%), dichloroacetaldehyde (0–0.03%), methyl hydrogen 2,2,2-trichloro-1-hydroxyethylphosphonate, demethyl trichlorfon (0–0.3%), and water (less than 0.3%). The technical product also contains phosphoric acid, 2,2,2-trichloro-1-hydroxyethylphosphonic acid, and dimethyl phosphite.

1.2 Physical and Chemical Properties

Trichlorfon is a colourless crystalline powder that is stable at room temperature. It is slowly hydrolysed in acid media; the half-life is 526 days at pH 1–5 and 20 °C. In alkaline media, at pH 8 and 37.5 °C, it hydrolyses initially to the more toxic compound dichlorvos, but is essentially 100% hydrolysed in 24 h to less toxic products, such as dimethyl hydrogen phosphate, dichloroacetaldehyde, and glyoxal. Trichlorfon also decomposes under ultraviolet irradiation.

Some physical properties are given in the Summary of Chemical Safety Information (section 6).

1.3 Analytical Methods

Trichlorfon residues can be determined using gas liquid chromatography. The same method can be used for product analysis; alternative methods include thin layer chromatography and high performance liquid chromatography.

1.4 Production and Uses

Trichlorfon was introduced as a commercial chemical in 1952. It is a broad spectrum insecticide that is particularly effective against Diptera. It is used mainly against insect pests in field and fruit crops, but it is also used to

PRODUCT IDENTITY AND USES

control forest insects and in public health. Further applications of trichlorfon include the control of endo- and ectoparasites in, or on, domestic animals and fish. Under the generic name of metrifonate, trichlorfon is used as an antihelminthic, and in the treatment of schistosomiasis in humans.

The global consumption of trichlorfon, which was more than 3000 tonnes in 1980, was reported to be approximately 850 tonnes in 1987.

Formulations used in agriculture are: 50% emulsifiable concentrate, 95, 80, and 50% soluble powders, 50% wettable powders, 5 and 4% dusts, 5, 2.5, and 1% granules, and 75, 50, 40, and 25% ultra-low volume concentrates.

The following formulations are used in the treatment of animals: 90, 80, and 50% soluble powders, 6% suspension, 11% solution, and 50% injectable solution tablets. A 1% fly bait is also available and a 0.1% preparation against house ants.

Tablets containing 100 mg metrifonate are used in the treatment of schistosomiasis in humans.

2. SUMMARY AND EVALUATION

2.1 Exposure

Trichlorfon is an organophosphorus insecticide that has been in use since the early 1950s. It is considered to be a slow release reservoir of dichlorvos.

The air concentration of trichlorfon insecticide may be as high as 0.1 mg/m^3 soon after spraying, but, within days, levels decrease to below 0.01 mg/m^3 . Levels of trichlorfon in runoff water from sprayed areas may be as high as $50 \text{ } \mu\text{g/litre}$, though levels in surface waters are usually much lower and decrease rapidly.

Trichlorfon is relatively stable in water at pH values below 5.5. At higher pH values, trichlorfon is transformed into dichlorvos. While microorganisms and plants may metabolize trichlorfon, the most important route of removal is abiotic hydrolysis.

Trichlorfon degrades rapidly in the soil, and levels generally decrease to negligible amounts within one month of application.

With a few exceptions, levels of trichlorfon on crops are below 10 mg/kg , the day after application, and below 0.1 mg/kg , two weeks later.

Milk from cows treated with trichlorfon for pest control may contain residues as high as 1.2 mg/litre , 2 h after application, but the levels decline to less than 0.1 mg/litre , 24 h after treatment. Significant levels of trichlorfon have not been found in the meat from treated animals. Eggs from treated hens have been found to contain $0.05 \text{ mg trichlorfon/kg}$.

2.2 Uptake, metabolism, and excretion

Trichlorfon is readily absorbed via all routes of exposure (oral, dermal, inhalation) and is rapidly distributed to the tissues of the body. Peak blood concentrations are detected within 12 h, with disappearance from the blood stream occurring in a matter of 1.5–4 h; only low levels are detected after 8–24 h. The biological half-life of trichlorfon in the mammalian blood is estimated to be about 30 min.

SUMMARY AND EVALUATION

Trichlorfon undergoes transformation, via dehydrochlorination, to form dichlorvos (2,2-dichlorovinyl dimethyl phosphate) in water and all biological fluids and tissues, at pH values higher than 5.5. Dichlorvos is a physiologically active anticholinesterase. The main routes of degradation of trichlorfon are demethylation, P-C bond cleavage, and ester hydrolysis via dichlorvos. The major metabolites of trichlorfon found *in vivo* are demethyl trichlorfon, demethyl dichlorvos, dimethyl hydrogen phosphate, methyl hydrogen phosphate, phosphoric acid, and trichloroethanol. The last of these metabolites is found in the urine as a glucuronide conjugate.

The elimination of trichlorfon and its metabolic products occurs primarily via the urine. Studies conducted with radiolabelled (¹⁴C-methyl and ³²P-) trichlorfon revealed that the bulk of the chemical was excreted as water-soluble material, little being chloroform-soluble. Some 66-70% of water-soluble products appeared in the urine within 12 h. Twenty-four percent of the ¹⁴C-methyl labelled material was eliminated in the expired air as carbon dioxide. Low levels of trichlorfon and its metabolites have been detected in the milk of cows treated with trichlorfon.

2.3 Effects on organisms in the environment

Trichlorfon is moderately toxic for fish (96-h LC₅₀ values range between 0.45 mg/litre and 51 mg/litre), and moderately to highly toxic for aquatic arthropods (48-h/96-h LC₅₀ values range between 0.75 µg/litre and 7800 µg/litre). However, the reported concentrations of trichlorfon found in surface waters, after application in forests at 6 kg/ha, fell short of these ranges. Thus, normal use of trichlorfon will have little or no effect on populations of aquatic organisms, since other groups, such as molluscs and microorganisms, are less sensitive than arthropods. Trichlorfon is moderately toxic for birds, LD₅₀ values from laboratory studies ranging between 40 mg/kg and 180 mg/kg body weight. However, field studies following aerial application of trichlorfon did not reveal any effects on the numbers, breeding pairs, nesting success, or mortality of forest songbirds. A reduction observed in singing and an increase in feeding activity may have resulted from a reduction in food organisms. There is no indication that trichlorfon will adversely affect organisms in the terrestrial environment other than arthropods. There is no information on the effects on beneficial arthropods.

SUMMARY AND EVALUATION

2.4 Effects on experimental animals and *in vitro* test systems

Trichlorfon is an insecticide that is moderately toxic for animals. The oral LD₅₀ values of technical trichlorfon in laboratory animals range from 400 to 800 mg/kg body weight; the dermal LD₅₀ values for the rat exceed 2000 mg/kg body weight. Trichlorfon poisoning causes the usual organophosphate cholinergic signs attributed to the accumulation of acetylcholine at nerve endings. Technical trichlorfon was shown to be moderately irritating to the eyes of rats, but was not irritating in skin tests on rabbits. Skin sensitization potential was demonstrated in guinea-pigs.

Short-term, oral toxicity studies were carried out on rats, dogs, monkeys, rabbits, and guinea-pigs. In a 16-week study on rats, a 4-year study on dogs, and a 26-week study on monkeys, no-observed-effect levels (NOELs) of 100 mg/kg diet, 50 mg/kg diet, and 0.2 mg/kg body weight (based on plasma, erythrocyte, or brain ChE activity) respectively, were determined. Inhalation exposure of rats, over a 3-week period, indicated a NOEL of 12.7 mg/m³, based on the inhibition of plasma, erythrocyte, and brain ChE activity. Long-term toxicity/carcinogenicity studies were carried out on mice, rats, monkeys, and hamsters, after oral, intraperitoneal, or dermal administration. An adverse effect on the gonads was demonstrated following the oral exposure of mice and rats at dose levels of 30 mg/kg body weight and 400 mg/kg diet, respectively. From a 24-month study on rats and a 10-year study on monkeys, no-observed-adverse-effect levels (NOAELs) of 50 mg/kg diet and 0.2 mg/kg body weight, respectively, were determined.

No evidence of carcinogenicity has been found following the long-term exposure of test animals using several routes of administration.

Under physiological conditions, trichlorfon has been reported to have a DNA-alkylating property. The trichlorfon mutagenicity results have been both positive and negative. Dichlorvos may be either partly or fully responsible for the effects observed. The results of most of the *in vitro* mutagenicity studies on both bacterial and mammalian cells were positive, while few of the *in vivo* studies produced positive results.

Studies on mice, rats, and hamsters indicate that trichlorfon produces a teratogenic response in rats at doses high enough to produce maternal toxicity. Exposure of rats to 145 mg/kg diet during gestation caused fetal malformations. A dose of 400 mg/kg body weight, administered by gavage

SUMMARY AND EVALUATION

to hamsters, also produced both maternal toxicity and a teratogenic response. The lowest dose by gavage that produced teratogenic effects in rats was 80 mg/kg body weight. The effects appeared to be time specific in the gestation period. The NOEL in this study was 8 mg/kg. NOAELS of 8 mg/kg body weight for rats and 200 mg/kg body weight for hamsters were demonstrated. Teratogenic responses involving the central nervous system have been reported for the pig and guinea-pig. However, no teratogenic effects were observed in a 3-generation reproduction study on rats, in which high dose levels induced adverse reproductive effects. The NOEL in this study was 300 mg/kg diet.

Very high doses have produced neurotoxicity in animals.

The active transformation product in mammals is dichlorvos, which is estimated to be at least 100 times more potent as an anticholinesterase than trichlorfon.

2.5 Effects on Human Beings

Several cases of acute poisoning from intentional (suicide) or accidental exposure have occurred. Signs and symptoms of intoxication included characteristics of AChE inhibition, such as exhaustion, weakness, confusion, excessive sweating and salivation, abdominal pains, vomiting, pinpoint pupils, and muscle spasms. In severe cases of poisoning, unconsciousness and convulsions developed and death usually resulted from respiratory failure. In cases where victims survived because of medical intervention, a delayed polyneuropathy associated with weakness of the lower limbs occurred a few weeks after exposure. In fatal cases, autopsy findings have shown ischaemic changes in the brain, spinal cord, and vegetative ganglia, damage to the myelin sheath in the spinal cord and brain peduncles, and structural changes in the axons of peripheral nerves.

A few cases of occupational poisoning have occurred, mainly because safety precautions were neglected. Occupational exposure at a workplace where air concentrations exceeded 0.5 mg/m^3 , resulted in decreased levels of plasma cholinesterase and changes in the EEG pattern. However, these effects were completely reversible on cessation of exposure. No cases of skin sensitization have been reported.

Trichlorfon has been extensively used for the treatment of schistosomiasis in humans. Administration of a single dose (7–12 mg/kg) resulted in

SUMMARY AND EVALUATION

40–60% inhibition of cholinesterase in the plasma and erythrocytes, without the manifestation of any cholinergic symptoms. However, mild symptoms were observed in cases with a repeated dose regimen. A high dose level (24 mg/kg) caused severe cholinergic symptoms.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Conclusions

Trichlorfon is a moderately toxic organophosphorus ester insecticide. Overexposure through handling during manufacture or use, or accidental or intentional ingestion may cause serious poisoning.

The general population is exposed to trichlorfon mainly as a result of agricultural and veterinary practices, and in the treatment of *Schistosoma haematobium*.

The reported trichlorfon intakes are far below the Acceptable Daily Intake established by FAO/WHO and should not constitute a health hazard for the general population.

With good work practices, hygienic measures, and safety precautions, trichlorfon is unlikely to present a hazard for those occupationally exposed.

Despite its high toxicity for non-target arthropods, trichlorfon has been used with little or no adverse effect on populations of organisms in the environment.

3.2 Recommendations

For the health and welfare of workers and the general population, the handling and application of trichlorfon should only be entrusted to competently supervised and well-trained

CONCLUSIONS AND RECOMMENDATIONS

operators, who will follow adequate safety measures and apply trichlorfon according to good application practices.

The manufacture, formulation, agricultural use, and disposal of trichlorfon should be carefully managed to minimize contamination of the environment, particularly surface waters.

Regularly exposed workers and patients should undergo periodic health evaluations.

The rates of application of trichlorfon should be limited, to avoid effects on non-target arthropods. The insecticide should never be sprayed over water bodies or streams.

4. HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

4.1 Main Human Health Hazards, Prevention and Protection, First Aid

Trichlorfon is an organophosphorus insecticide. Technical trichlorfon and concentrated formulations are slightly toxic (acute, oral LD₅₀ for the rat: 560 mg/kg), but can be hazardous for human beings if incorrectly handled. Trichlorfon is hazardous through ingestion and skin contact, because of rapid absorption. Typical signs and symptoms of organophosphorus poisoning may occur rapidly with overexposure.

Cases of delayed neurotoxicity have been reported as well as sporadic cases of effects on spermatogenesis.

The human health hazards associated with certain types of exposure to trichlorfon, together with preventive and protective measures and first aid recommendations are listed in the Summary of Chemical Information (section 6).

4.1.1 *Advice to physicians*

4.1.1.1 *Symptoms of poisoning*

Trichlorfon is an indirect inhibitor of cholinesterase, i.e., it is converted in the body into the active transformation product, dichlorvos. As a result, signs and symptoms of overexposure develop after a latent period and may continue to increase after exposure has been discontinued. Initially, there may be feelings of exhaustion, headache, weakness, and confusion. Then, vomiting, abdominal pain, and excessive sweating and salivation may develop. The pupils are small. Difficulty in breathing may be experienced, due to either congestion of the lungs or weakness of the respiratory muscles. In severe cases of poisoning, muscle spasms, unconsciousness, and convulsions may develop. Death results from respiratory failure.

For a more complete treatise on the effects of organophosphorus insecticides, especially their short- and long-term effects on the nervous system, refer to Environmental Health Criteria 63: Organophosphorus insecticides – a general introduction (WHO 1968).

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

4.1.1.2 *Medical treatment*

Since trichlorfon formulations may contain petroleum distillates, it is preferable not to induce vomiting. In the case of ingestion of liquid formulations containing hydrocarbon solvents, vomiting involves a risk of aspiration pneumonia. Instead, the stomach should be emptied, as soon as possible, by careful gastric lavage using 5% sodium bicarbonate (with a cuffed endotracheal tube already in place). If possible, identify the solvents present in the formulation and observe the victim for additional toxic effects. As early as possible, administer 2 mg of atropine sulfate intravenously and 1000–2000 mg of pralidoxime chloride or 250 mg of obidoxime chloride (adult dose), intramuscularly or intravenously, to patients suffering from severe respiratory difficulties, convulsions, or unconsciousness. Repeated doses of 2 mg of atropine sulfate should be given, as required, based on the respiration, blood pressure, pulse frequency, salivation, and convulsion conditions. For children, the doses are 0.04–0.08 mg of atropine/kg body weight, 250 mg of pralidoxime chloride per child or 48 mg of obidoxime chloride/kg body weight.

Diazepam 10 mg (adult dose) should be given, subcutaneously or intravenously, in all but the mildest cases.

Artificial respiration should be applied, if required.

Morphine, barbiturates, phenothiazine derivatives, tranquillizers, and all kinds of central stimulants are contraindicated.

The diagnosis of intoxication should be confirmed as soon as possible by the determination of the cholinesterase activity (ChE) in venous blood.

For more information on the treatment of poisoning by organophosphorus insecticides see Environmental Health Criteria 63: Organophosphorus insecticides: - a general introduction (WHO 1986). The section on therapy from this publication is attached as Annex 1 of this guide.

4.1.2 *Health surveillance advice*

Occupational exposure to organophosphorus insecticides can be monitored by the measurement of erythrocyte- and whole blood-ChE activity.

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

Physiological variations in erythrocyte- and blood-ChE values occur in a healthy persons.

Inhibition of acetyl-cholinesterase (AChE) or ChE activities of less than 20–25% is considered diagnostic of exposure, but not necessarily indicative of hazard. However, work procedures and hygiene should be checked. Inhibition of 30–50% or more is considered an indication that an exposed individual should be removed from further contact with ChE-inhibiting pesticides, until values return to normal. Work procedures and hygiene should also be checked.

4.2 Explosion and Fire Hazards

Liquid formulations may be flammable. Inform the fire service that skin contamination and the breathing of fumes must be avoided. Protective clothing and self-contained breathing apparatus must be worn.

Extinguish fires with alcohol-resistant foam or powder. The use of water spray should be confined to the cooling of unaffected stock, to avoid polluted runoff from the site.

4.3 Storage

Technical trichlorfon and its formulations should be stored in locked, well-ventilated buildings, preferably buildings specifically used for insecticide storage. Do not expose to direct sunlight. Keep products out of reach of children and unauthorized personnel. Do not store near animal feed or foodstuffs.

4.4 Transport

Comply with any local regulations regarding the movement of hazardous goods. Do not load with animal feed or foodstuffs. Check that containers are sound and labels undamaged before despatch.

HUMAN HEALTH HAZARDS, PREVENTION AND PROTECTION, EMERGENCY ACTION

4.5 Spillage and Disposal

4.5.1 Spillage

Stay upwind, avoid skin contamination and inhalation of vapour. Absorb spilled liquid, and cover contaminated areas with a 1:3 mixture of sodium carbonate crystals and damp sawdust, lime, sand, or earth. Sweep up and place the sweepings in a closeable, impervious container. Ensure that the container is tightly closed and suitably labelled before transfer to a safe place for disposal.

Prevent liquid from spreading and contaminating other cargo, vegetation, or waterways with a barrier of the most suitable material available, e.g., earth or sand. If the spill occurs into a waterway and the trichlorfon-containing material is immiscible with water and sinks, dam the waterway to stop the flow and to retard dissipation by water movement. Use a bottom pump, dredging, or underwater vacuum equipment to remove undissolved material.

Empty any of the product remaining in a damaged/leaking container into a clean empty container, which should then be tightly closed and suitably labelled.

Decontaminate emptied leaking containers with a 10% sodium carbonate solution added at the rate of at least 1 litre per 20-litre drum. Swirl round to rinse walls, empty, and add rinsings to sawdust, etc. Puncture empty containers to prevent re-use.

4.5.2 Disposal

Contaminated absorbents, containers, surplus product, etc., should be burnt in a proper incinerator, at high temperatures, with effluent gas scrubbing. When no incinerator is available, bury in an approved dump, or in an area where there is no risk of contamination of surface or ground water. Before burying, liberally mix with sodium carbonate (washing soda) crystals to help neutralize the product and mix with soil rich in organic matter. Comply with any local legislation.

5. HAZARDS FOR THE ENVIRONMENT AND THEIR PREVENTION

Trichlorfon is moderately toxic for birds and fish, but highly toxic for arthropods. It does not bioaccumulate, and it breaks down rapidly in the environment.

Avoid contamination of the soil, water, and atmosphere by proper methods of storage, transport, handling, and waste disposal.

In case of spillage, use the methods advised in section 4.5.1.

6. SUMMARY OF CHEMICAL SAFETY INFORMATION

This summary should be easily available to all health workers concerned with, and users of, trichlorfon. It should be displayed at, or near, entrances to areas where there is potential exposure to trichlorfon, and on processing equipment and containers. The summary should be translated into the appropriate language(s). All persons potentially exposed to the chemical should also have the instructions in the summary clearly explained.

Space is available for insertion of the National Occupational Exposure Limit, the address and telephone number of the National Poison Control Centre, and local trade names.

SUMMARY OF CHEMICAL SAFETY INFORMATION

TRICHLORFON

Chemical formula: C₄H₉Cl₃O₄P

CAS chemical name: dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate

CAS registry number: 52-68-6

PHYSICAL PROPERTIES

Appearance
Melting point
Boiling point
Vapour pressure
Volatility

colourless crystals
83-84 °C
100 °C (0.1 mmHg)
7.8 × 10⁻⁶ mmHg (20 °C)
0.022 mg/m³ (20 °C)

Density

d_4^{20} 1.73

Solubility at 25 °C in g/100 ml

water 15.4
benzene 15.2
chloroform 75.0
diethyl ether 17.0
n-hexane 0.08

Partition coefficient
(octanol/water) log P_{ow}

0.57

Corrosiveness

corrosive to metals

OTHER CHARACTERISTICS

Colourless crystalline powder; stable at room temperature; slowly hydrolysed in acid media, with half-life of 526 days at pH 1-5 (20 °C); at pH 8 (37.5 °C) hydrolyses to dichlorvos, but 100% transformed to less toxic products within 24 h; decomposes under ultraviolet radiation

HAZARD/SYMP TOM	PREVENTION AND PROTECTION	FIRST AID
<p>GENERAL: readily absorbed via skin, ingestion, and inhalation; may cause organophosphate poisoning: weakness, headache, vomiting, excessive sweating and salivation, pinpoint pupils; in severe cases: convulsions, unconsciousness, and death due to respiratory paralysis</p>		
<p>SKIN: irritation; redness; extensive contamination may cause poisoning</p>	<p>Wear PVC or neoprene gloves and apron; rubber boots</p>	<p>Remove and wash contaminated clothing; wash contaminated skin with water and soap; obtain medical attention immediately</p>
<p>EYES: irritation; redness</p>	<p>Wear safety goggles or face shield</p>	<p>Flush eyes with clean water for at least 15 min; if irritation persists, obtain medical attention immediately</p>
<p>INHALATION: overexposure may cause poisoning</p>	<p>Avoid breathing the vapour; use proper (exhaust) ventilation or suitable respiratory protection</p>	<p>In case of signs and symptoms, remove from contaminated area and obtain medical attention immediately</p>

SUMMARY OF CHEMICAL SAFETY INFORMATION (continued)

HAZARD/SYMPTOM	PREVENTION AND PROTECTION	FIRST AID
<p>INGESTION: an unlikely occupational hazard</p> <p>Accidental or intentional ingestion may rapidly lead to severe poisoning</p> <p>REPEATED EXPOSURE BY INHALATION OR INGESTION, OR THROUGH SKIN may gradually lead to signs and symptoms associated with inhibition of cholinesterase activity</p>	<p>Wash hands before eating, drinking, using the toilet, and after work</p> <p>As above</p>	<p>Induce vomiting, if the subject is conscious, except in the case of an emulsifiable concentrate; obtain medical attention immediately</p> <p>Obtain medical attention immediately; if breathing has stopped, apply artificial respiration</p> <p>As above</p>

7. CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

The information given in this section has been extracted from the International Register of Potentially Toxic Chemicals (IRPTC) legal file. A full reference to the original national document from which the information was extracted can be obtained from IRPTC. When no effective date appears in the IRPTC legal file, the year of the reference from which the data are taken is indicated by (r).

The reader should be aware that regulatory decisions about chemicals taken in a certain country can only be fully understood in the framework of the legislation of that country. Furthermore, the regulations and guidelines of all countries are subject to change and should always be verified with appropriate regulatory authorities before application.

7.1 Previous Evaluations by International Bodies

Trichlorfon was evaluated by the Joint FAO/WHO Meeting on Pesticide Residues (JMPR) in 1971, 1975, and 1978. In 1978, the JMPR established an Acceptable Daily Intake (ADI) for humans of 0-0.01 mg/kg body weight.

The International Agency for Research on Cancer (IARC) evaluated trichlorfon in 1987, and concluded that the data were inadequate to evaluate its carcinogenicity for experimental animals, and that no data on its carcinogenicity for humans were available. It was therefore classified in Group 3.

The International Programme on Chemical Safety (WHO) classified technical trichlorfon as "slightly hazardous" (Class III). WHO has issued a data sheet on trichlorfon (No. 27).

7.2 Exposure Limit Values

Some exposure limit values are given in the table on pp. 28-29. When considering exposure limits, however, it is important also to include any residues of its major conversion product, dichlorvos (see HSG No. 18: Dichlorvos).

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

EXPOSURE LIMIT VALUES

Medium	Specification	Country/ organization	Exposure limit description	Value	Effective date
AIR	Workplace	Hungary	Maximum allowable concentration (MAC) - Ceiling value	0.5 mg/m ³	1988
AIR	Ambient	USSR	Maximum allowable concentration (MAC) - Ceiling value (vapour + aerosol)	0.5 mg/m ³	1977
AIR	Ambient	USSR	Maximum allowable concentration (MAC) (average per day) - Ceiling value	0.04 mg/m ³ 0.5 mg/m ³	1984
FOOD	Intake from	FAO/WHO	Acceptable daily intake (ADI)	0-0.01 mg/kg body weight	1978

FOOD	Residue	FAO/WHO	Maximum residue limit (MRL) products specified as follows:	0.05-2 mg/kg 1986, 1988, 1989
			- Carrots, eggplants (aubergines), milk, parsley, sugar beets	0.05mg/kg
			- Artichokes, beans (black-eyed, green, lima), cattle (carcass, meat, byproducts, fat), cereal grains, cherries, citrus fruits, cotton seed, cow peas, linseed, mustard greens, peanuts (shell-free), pigs (carcass meat, byproducts, fat), pumpkins, radishes, rapeseed, safflower seed (plus cob), sheep (carcass meat), soya beans, turnips	0.1mg/kg
			- Bananas (pulp), beet root, brussels sprouts, cauliflower, celery, kale, peaches, sweet corn (kernels + cob), tomatoes	0.2mg/kg
			- Cabbage, grapes, lettuce, spinach	0.5mg/kg
			- Banana, peppers, strawberries	1.0mg/kg
			- Apples	2.0mg/kg
WATER	Surface fishing	USSR	Maximum allowable concentration	0.05 mg/kg 1983
		USSR	Maximum allowable concentration	0.00 mg/kg 1983
SOIL		USSR	Maximum allowable concentration	0.05 mg/kg 1976

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

7.3 Specific Restrictions

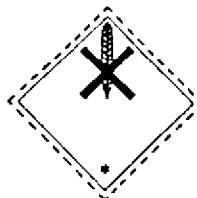
Trichlorfon has been officially approved for use as a pesticide in most countries. In some countries, specific uses as well as limitations and precautions are defined. In the USSR, it was banned for use in livestock farming in 1987. In Norway, its use is not permitted for medical treatment.

7.4 Labelling, Packaging, and Transport

The United Nations Committee of Experts on the Transportation of Dangerous Goods classifies trichlorfon in:

Hazard Class 6.1:	poisonous substance;
Packing Group III:	a substance presenting a relatively low risk of poisoning in transport, for material containing 70% (solid) or 23% (liquid).

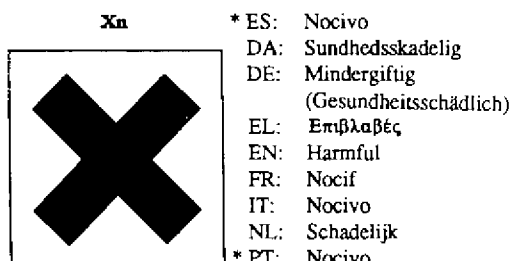
The label should be as follows:



The bottom half of the label should bear the inscriptions:
HARMFUL
Stow away from foodstuffs
Symbol (St. Andrew's Cross over an ear of wheat): black; Background: white

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

The European Economic Community legislation requires labelling as dangerous substance using the symbol:



The label must read:

Harmful by inhalation, in contact with skin and if swallowed; keep out of reach of children; keep away from food, drink and animal feeding stuffs.

The European Economic Community legislation on the labelling of pesticide preparations classifies trichlorfon in Class IIB for the purpose of determining the labels for preparations containing trichlorfon and other active ingredients.

WHO gives the following product specification for technical trichlorfon for use in public health:

“The material shall consist of trichlorfon together with related manufacturing compounds and shall be in the form of a white crystalline powder free from extraneous impurities or added modifying agents.”

The material should contain at least 970 g trichlorfon per kg. The acidity and water content are specified and analytical methods for checking are given.

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

The specification continues:

"The technical trichlorfon shall be packed in suitable, clean containers, as specified in the order.

"All packages shall bear, durably and legibly marked on the container, the following:

Manufacturer's name

Technical trichlorfon to specification WHO/SIT/13.R3

Batch or reference number, and date of test

Net weight of contents

Date of manufacture

and the following minimum cautionary notice:

"Trichlorfon is an organophosphorus compound that inhibits cholinesterase. It is poisonous if swallowed or absorbed through the skin. Avoid skin contact; wear protective gloves and clean protective clothing while using the material. Wash thoroughly with soap and water after using.

"Keep the material out of the reach of children, and well away from foodstuffs, and animal feed, and their containers.

"If poisoning occurs, call a physician. Atropine and pralidoxime are specific antidotes, and artificial respiration may be needed."

Similar specifications and instructions are given for trichlorfon emulsifiable concentrate and water-soluble powder.

FAO gives similar product specifications for trichlorfon for its use in plant protection. In this case, the technical material should contain at least 97% active material. Containers must comply with pertinent national and international transport and safety regulations.

CURRENT REGULATIONS, GUIDELINES, AND STANDARDS

7.5 Waste Disposal

In the USA, any waste containing trichlorfon is considered a hazardous waste and permits are required for its handling, transport, treatment, storage, discharge, and disposal.

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ANNEX I

TREATMENT OF ORGANOPHOSPHATE INSECTICIDE POISONING IN MAN

(From EHC 63: Organophosphorus Insecticides – A General Introduction)

All cases of organophosphorus poisoning should be dealt with as an emergency and the patient sent to hospital as quickly as possible. Although symptoms may develop rapidly, delay in onset or a steady increase in severity may be seen up to 48 h after ingestion of some formulated organophosphorus insecticides.

Extensive descriptions of treatment of poisoning by organophosphorus insecticides are given in several major references (Kagan, 1977; Taylor, 1980; UK DHSS, 1983; Plestina, 1984) and will also be included in the IPCS Health and Safety Guides to be prepared for selected organophosphorus insecticides.

The treatment is based on:

- (a) minimizing the absorption;
- (b) general supportive treatment; and
- (c) specific pharmacological treatment.

I.1 Minimizing the Absorption

When dermal exposure occurs, decontamination procedures include removal of contaminated clothes and washing of the skin with alkaline soap or with a sodium bicarbonate solution. Particular care should be taken in cleaning the skin area where venupuncture is performed. Blood might be contaminated with direct-acting organophosphorus esters and, therefore, inaccurate measures of ChE inhibition might result. Extensive eye irrigation with water or saline should also be performed. In the case of ingestion, vomiting might

ANNEX I

be induced, if the patient is conscious, by the administration of ipecacuanha syrup (10–30 ml) followed by 200 ml water. This treatment is, however, contraindicated in the case of pesticides dissolved in hydrocarbon solvents. Gastric lavage (with addition of bicarbonate solution or activated charcoal) can also be performed, particularly in unconscious patients, taking care to prevent aspiration of fluids into the lungs (i.e., only after a tracheal tube has been put in place).

The volume of fluid introduced into the stomach should be recorded and samples of gastric lavage frozen and stored for subsequent chemical analysis. If the formulation of the pesticide involved is available, it should also be stored for further analysis (i.e., detection of toxicologically relevant impurities). A purgative can be administered to remove the ingested compound.

I.2 General Supportive Treatment

Artificial respiration (via a tracheal tube) should be started at the first sign of respiratory failure and maintained for as long as necessary.

Cautious administration of fluids is advised, as well as general, supportive and symptomatic pharmacological treatment and absolute rest.

I.3 Specific Pharmacological Treatment

I.3.1 *Atropine*

Atropine should be given, beginning with 2 mg iv and given at 15–30-min intervals. The dose and the frequency of atropine treatment varies from case to case, but should maintain the patient fully atropinized (dilated pupils, dry mouth, skin flushing, etc.). Continuous infusion of atropine may be necessary in extreme cases and total daily doses of up to several hundred mg may be necessary during the first few days of treatment.

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I.3.2 *Oxime reactivators*

Cholinesterase reactivators (e.g., pralidoxime, obidoxime) specifically restore AChE activity inhibited by organophosphates. This is not the case with enzymes inhibited by carbamates. The treatment should begin as soon as possible, because oximes are not effective on "aged" phosphorylated ChEs. However, if absorption, distribution, and metabolism are thought to be delayed for any reasons, oximes can be administered for several days after intoxication. Effective treatment with oximes reduces the required dose of atropine. Pralidoxime is the most widely available oxime. A dose of 1 g pralidoxime can be given either im or iv and repeated 2-3 times per day or, in extreme cases, more often. If possible, blood samples should be taken for AChE determinations before and during treatment. Skin should be carefully cleansed before sampling. Results of the assays should influence the decision on whether to continue oxime therapy after the first 2 days.

There are indications that oxime therapy may possibly have beneficial effects on CNS-derived symptoms.

I.3.3 *Diazepam*

Diazepam should be included in the therapy of all but the mildest cases. Besides relieving anxiety, it appears to counteract some aspects of CNS-derived symptoms, which are not affected by atropine. Doses of 10 mg s.c. or i.v. are appropriate and may be repeated as required (Vale & Scott, 1974). Other centrally acting drugs and drugs that may depress respiration are not recommended in the absence of artificial respiration procedures.

I.3.4 *Notes on the recommended treatment*

I.3.4.1 *Effects of atropine and oxime*

The combined effect far exceeds the benefit of either drug singly.

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1.3.4.2 Response to atropine

The response of the eye pupil may be unreliable in cases of organophosphorus poisoning. A flushed skin and drying of secretions are the best guide to the effectiveness of atropinization. Although repeated dosing may well be necessary, excessive doses at any one time may cause toxic side-effects. Pulse-rate should not exceed 120/min.

1.3.4.3 Persistence of treatment

Some organophosphorus pesticides are very lipophilic and may be taken into, and then released from, fat depots over a period of many days. It is therefore quite incorrect to abandon oxime treatment after 1-2 days on the supposition that all inhibited enzyme will be aged. Ecobichon et al. (1977) noted prompt improvement in both condition and blood-ChEs in response to pralidoxime given on the 11th-15th days after major symptoms of poisoning appeared due to extended exposure to fenitrothion (a dimethyl phosphate with a short half-life for aging of inhibited AChE).

1.3.4.4 Dosage of atropine and oxime

The recommended doses above pertain to exposures, usually for an occupational setting, but, in the case of very severe exposure or massive ingestion (accidental or deliberate), the therapeutic doses may be extended considerably. Warriner et al. (1977) reported the case of a patient who drank a large quantity of dicrotophos, in error, while drunk. Therapeutic dosages were progressively increased up to 6 mg atropine i.v. every 15 min together with continuous i.v. infusion of pralidoxime chloride at 0.5 g/h for 72 h, from days 3 to 6 after intoxication. After considerable improvement, the patient relapsed and further aggressive therapy was given at a declining rate from days 10 to 16 (atropine) and to day 23 (oxime), respectively. In total, 92 g of pralidoxime chloride and 3912 mg of atropine were given and the patient was discharged on the thirty-third day with no apparent sequelae.

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