WHO/CDS/CPE/WHOPES/99.5

World Health Organization

Safety to Pyrethroid-treated mosquitoe nets

DEPARTMENT OF CONTROL, PREVENTION AND ERADICATION - PROGRAMME ON COMMUNICABLE DISEASES
WHO PESTICIDE EVALUATION SCHEME (WHOPES)

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INTRODUCTION

Malaria accounts for a large part of the disease burden of poor countries, causing over a million deaths a year, mainly in African children. There are an estimated 300-500 million episodes of acute illness annually, affecting up to one in ten of the world's population.

Insecticide treated mosquito nets effectively reduce malaria morbidity and mortality in many different epidemiological settings. Their use may not only benefit the people who are actually sleeping under them, but when used by the majority of the community, people who sleep without treated nets may also receive fewer infective bites.

Table 1 lists the insecticide products which have successfully passed the WHO Pesticide Evaluation Scheme (WHOPES), and gives the recommended dosages for treatment of mosquito nets against malaria vectors. All listed products are pyrethroid insecticides which are presently the only group of insecticides recommended for this use. This is due to their safety for humans and repellency, high knock down effect, irritancy and efficacy at low dosages, for mosquitoes. WHO specifications for the listed products, used for quality control, are available on request from WHO Pesticide Evaluation Scheme, Department of Control, Prevention and Eradication, Programme on Communicable Diseases, World Health Organization, 1211 Geneva 27, Switzerland, and are also available on the WHO homepage on the Internet (www.who.ch/ctd).

Table 1. WHO recommended insecticides for treatment of mosquito nets for malaria vector control.

INSECTICIDE	FORMULATION[1]	DOSAGE[2]
Alpha-cypermethrin	*SC 10%*	*20-40*
Cyfluthrin	*EW 5%*	*50*
Deltamethrin	*SC 1% and WT 25%[3]*	*15-25*
Etofenprox	*EW 10%*	*200*
Permethrin	*EC 10%*	*200-500*

1 SC= suspension concentrate; EW=emulsion, oil in water; WT=water dispersible tablet; EC: emulsifiable concentrate.
2 Milligrams of active ingredient per square metre of netting.
3 WHO specifications under development

This document reviews the toxicity and hazards of insecticides and insecticide treated mosquito nets and provides relevant recommendations on their safe use. Special consideration has been given to supply of insecticide products for treatment of mosquito nets "over the counter".

II TOXICITY AND HAZARDS II

Toxicity and hazard are not synonymous terms. Toxicity is the inherent poisonous potency of a compound under experimental conditions, while hazard refers to the risk or danger of poisoning when a chemical is used or applied.

The toxicity of pyrethroids is due to their affinity for and intrinsic effect on receptors or targets within the sodium channels essential for nerve conduction. Being highly lipophilic, pyrethroids pass through cell membranes and are absorbed through the skin, by inhalation and by ingestion. However, their rapid metabolism greatly lowers the magnitude of the resultant toxicity.

People are at risk of exposure to insecticides through accidental swallowing or drinking of the insecticide products, inhaling solvent vapours of EC formulations, splashing the product into the eyes or onto the skin during the net treatment, and insecticide residues during the net use.

CHRONIC TOXICITY

The chronic toxicity of the common insecticide products used for treatment of mosquito nets are presented in *Table 2* as the relevant "no observed adverse effect level" (NOAEL) and acceptable daily intake (ADI). NOAEL is the dosage of an insecticide that results in no discernible harm to experimental animals in chronic toxicity studies that include the close examination of all body organs for abnormalities. The ADI is the daily exposure level of the insecticide residue, expressed as mg/kg body weight, that, over the entire lifetime of a human being, appears to be without appreciable risk, on the basis of all facts known at a given time, and has been calculated from the relevant NOAEL, with a safety factor of 100. Thus, for example, an ADI of 0.01 mg of active ingredient/kg body weight is a safety standard value which corresponds to daily intake (licking) of 0.1 mg active ingredient of the insecticide, by a 10 kg child, from the treated net. At the target dosage of 25 mg/m^2, such an amount of insecticide is present on an area of 6 x 6 cm. However, pyrethroids bind strongly to the fabric and even in washing with soap and water, only part of the insecticide is removed. Therefore there is no indication to suggest that the accidental licking of the net would pose a health hazard to the child.

Table 2. The chronic toxicity of insecticides commonly used for treatment of mosquito nets.

PRODUCT	RELEVANT NOAEL mg a.i./kg bw/day	ADI mg a.i./kg bw (safety factor of 100)
Alpha-cypermethrin	*1.5*	*0-0.02*
Cyfluthrin	*2*	*0-0.02*
Deltamethrin	*1*	*0-0.01*
Etofenprox	*3.1*	*0-0.03*
Permethrin	*5*	*0-0.05*

In long-term toxicity studies of pyrethroid insecticides commonly used for treatment of mosquito nets, there have been no teratogenic, carcinogenic or mutagenic effect in experimental animals. The volatility of pyrethroids is also low; given the low dosages of insecticide used for the treatment of nets, the risk of inhalation toxicity by the users of treated nets is remote.

Acute toxicity

Table 3 shows the LD_{50} values in rats from both oral and dermal administration of the common insecticides used for treating mosquito nets. The LD_{50} is a statistical estimate of the amount of a substance required to kill 50% of a population of test animals. These values are relevant for comparing with single or multiple exposures of the insecticide over a relatively short period of time that might be encountered accidentally or by a person handling the product.

Table 3. Acute oral and dermal toxicity of insecticide formulations commonly used for treatment of mosquito nets, as reported by manufacturers in the Material Safety Data Sheets of the products[1].

Product	Oral toxicity: LD_{50} Value mg/kg bw, rats	Dermal toxicity: LD_{50} Value mg/kg bw, rats
Alpha-cypermethrin SC 10%	*4,932*	*2,000*
Cyfluthrin EW 5%	*2,100*	*>5,000*
Deltamethrin SC 1%	*>10,000*	*>10,000*
Deltamethrin WT 25%	*1,965*	*2,000 rabbit*
Etofenprox EW 10%	*>5,000*[2]	*>5,000*
Permethrin EC 10%	*5,000–6,000*	*4,000–10,000*

1 The material safety data sheets of 3 major manufacturers have been consulted for provision of data relating to permethrin EC 10%.

2 The exact figure for the acute oral toxicity of etofenprox EW 10%, a non-ester pyrethroid, is not available. However, by extrapolation from the figures for active ingredient, it would give a figure of >400,000 mg/kg bw.

As previously mentioned, acute toxicity may occur through treatment and handling of insecticides for treatment of mosquito nets. People directly involved in dipping large numbers of nets are at most risk. However, those who occasionally treat their own net are less exposed to insecticide hazard.

Among available liquid formulations, the water based products, i.e., EW (emulsion, oil in water) and SC (suspension concentrate) formulations are preferred. They are less smelly and are less [illegible]