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# GLOBAL COLLABORATION FOR DEVELOPMENT OF PESTICIDES FOR PUBLIC HEALTH (GCDPP)

## Past and Present of Chagas Vector Control and Future Needs

**Position Paper**

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## 1. Introduction

Chagas disease or American trypanosomiasis occurs on the American continent in the area between 42° N and 45° S latitudes, where it infects 16-18 million people. Some 100 million people, a quarter of all the inhabitants of Latin America, are at risk of contracting the disease (1).

Chagas disease is a chronic and incurable parasitic infection that causes disability and death. It is caused by a flagellate protozoan, *Trypanosoma cruzi*, which is transmitted to humans in the feces of blood sucking triatomine bugs. There are 3 genera of triatomines incriminated in the transmission of Chagas disease: *Triatoma*, especially *T. infestans*, *T. dimidiata* and *T. sordida*; *Rhodnius*, especially *R. prolixus* and *R. pallescens* and *Pastrongylus*, especially *P. megistus* (2).

The number of disability-adjusted life years lost (DALYs) because of Chagas disease amounts to 2,740,000 and represents the third largest tropical disease burden after malaria and schistosomiasis in Latin America (3). No treatment is available for the chronic forms of the disease and there is no acquired immunity. Chemical control of the vectors appears to be the best way to reduce the incidence of the disease (2, 3). Chemical control has been based principally on spraying dwellings and peridomiciliary areas with insecticide formulations applied by professional sprayers. The active ingredients used since the 1960's were chlorinated hydrocarbons, organophosphorus, carbamate and pyrethroid insecticides. Chemical vector control programmes at the national level have been implemented in Argentina, Brazil and Venezuela.

Activities for the control of Chagas disease vectors involve three stages (5):

1. *Preparatory phase:* Includes the mapping of the area to be treated, the programme of control activities and estimation of resources.

2. *Attack phase:* In this phase a blanket insecticide spray coverage of infested houses takes place, followed by a second spraying of re-infested houses no more than 6 months later.

3. *Surveillance phase:* When the objective of the attack phase, i.e., interruption of transmission, has been reached vigilance activities are performed to detect and control residual foci of triatomines.

   Control activities based on the above 3 stages are not always strictly followed. In some cases the second spraying of the attack phase is not carried out or a mix of attack and surveillance phases are performed.

## 2. Historical background

The wartime success of DDT in controlling malaria (6) stimulated Latin American entomologists to test this insecticide in the 1950s for the control of Chagas vectors. Unexpectedly, DDT had to be discarded because of its low level of efficacy against triatomine vectors of Chagas disease. The low triatomicidal power of DDT was due to two degradation pathways in *T. infestans* (7, 8). These pathways are mediated by a DDT – dehydrochlorinase and by a DDT hydroxylase which metabolize DDT to DDE and kelthane respectively (7,8). Delayed penetration of DDT in starved nymphs of *T. infestans* was shown to be a

complementary cause of the tolerance to this insecticide (9).

After the unexpected failure of DDT, the first option among the chlorinated hydrocarbons was HCH, which was successfully introduced for the control of the Chagas disease vectors in 1947 (10).

## 3. Insecticides used

### 3.1 Chlorinated hydrocarbons

DDT was first introduced for triatomine control and rapidly replaced by HCH. This product is a mixture of five isomers of hexachlorocyclohexane (11). The $\gamma$ isomer, lindane is the active component of HCH. This was the only isomer with insecticidal activity against *T. infestans* (B. D'Agostino and E. Zerba, unpublished data).

The dosage of lindane needed for the control of Chagas disease vectors was 500 mg/m$^2$. The treatments were expensive and time consuming because two successive sprays cycles per year was necessary for a successful control. The initial application eliminated the nymphs and adults while the second, 1 to 6 months later, eliminated the nymphs born from eggs hatched before the end of the residual activity of the insecticide.

Venezuela introduced dieldrin in 1947 for the control *Rhodnius prolixus,* the principal vector in the region (10). The use of dieldrin was a consequence of the DDT failure in the initial control actions in Venezuela to reduce the incidence of Chagas disease.

In the early 1960's the enormous impact of Rachel Carson's book "Silent Spring" drew attention to the

potential of chlorinated hydrocarbon insecticides to adversely affect the environment. The high chemical stability and the potential toxicological and ecotoxicological risk of chlorinated insecticides caused their progressive substitution by compounds with more favorable properties. Organophosphorus and carbamate insecticides were less persistent, non-bioaccumulative alternative insecticides for the control of Chagas disease vectors.

### 3.2 Anti-cholinesterase compounds

Organophosphorus and carbamate insecticides kill insects by inhibiting acetylcholinesterase, with consequent disruption of nervous activity caused by accumulation of acetylcholine at post-synaptic nerve junctions (11). Propoxur was the first anti-cholinesterase insecticide used for the control of triatomine vectors of Chagas disease. The triatomicidal effect of this carbamate was established in 1968 and the initial field trials were performed in Chile between 1969-1971 (9).

The phosphorothionates malathion and fenitrothion were introduced in 1975 into Chagas vector control programmes. These anti-cholinesterase compounds with ovicidal action (12) had lower vapour pressure and a higher initial impact of control than HCH, allowing spacing between applications of 1 year. Many phosphorothionates have the disadvantage of a strong and unpleasant smell, which results in villagers' resistance to the house treatments. These compounds are a good alternative for treatments in outhouses and other peridomestic structures (13).