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PLOS | NEGLECTED TROPICAL DISEASES

# Contact Irritant Responses of *Aedes aegypti* Using Sublethal Concentration and Focal Application of Pyrethroid Chemicals

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## Abstract

***Background:*** Previous studies have demonstrated contact irritant and spatial repellent behaviors in *Aedes aegypti* following exposure to sublethal concentrations of chemicals. These sublethal actions are currently being evaluated in the development of a push-pull strategy for *Ae. aegypti* control. This study reports on mosquito escape responses after exposure to candidate chemicals for a contact irritant focused push-pull strategy using varying concentrations and focal application.

***Methods:*** Contact irritancy (escape) behavior, knockdown and 24 hour mortality rates were quantified in populations of female *Ae. aegypti* under laboratory conditions and validated in the field (Thailand and Peru) using experimental huts. Evaluations were conducted using varying concentrations and treatment surface area coverage (SAC) of three pyrethroid insecticides: alphacypermethrin, lambacyhalothrin and deltamethrin.

***Results:*** Under laboratory conditions, exposure of *Ae. aegypti* to alphacypermethrin using the standard field application rate (FAR) resulted in escape responses at 25% and 50% SAC that were comparable with escape responses at 100% SAC. Significant escape responses were also observed at <100% SAC using ½FAR of all test compounds. In most trials, KD and 24 hour mortality rates were higher in mosquitoes that did not escape than in those that escaped. In Thailand, field validation studies indicated an early time of exit (by four hours) and 40% increase in escape using ½FAR of alphacypermethrin at 75% SAC compared to a matched chemical-free control. In Peru, however, the maximum increase in *Ae. aegypti* escape from alphacypermethrin-treated huts was 11%.

***Conclusions/Significance:*** Results presented here suggest a potential role for sublethal and focal application of contact irritant chemicals in an *Ae. aegypti* push-pull strategy to reduce human–vector contact inside treated homes. However, the impact of an increase in escape response on dengue virus transmission is currently unknown and will depend on rate of biting on human hosts prior to house exiting.

**Citation:** Manda H, Shah P, Polsomboon S, Chareonviriyaphap T, Castro-Llanos F, et al. (2013) Contact Irritant Responses of *Aedes aegypti* Using Sublethal Concentration and Focal Application of Pyrethroid Chemicals. PLoS Negl Trop Dis 7(2): e2074. doi:10.1371/journal.pntd.0002074

**Editor:** Pattamaporn Kittayapong, Mahidol University, Thailand

**Received** July 11, 2012; **Accepted** January 8, 2013; **Published** February 28, 2013

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**Funding:** Funding for this research was supported by the Bill & Melinda Gates Foundation (Grant #48513). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

**Competing Interests:** The authors have declared that no competing interests exist.

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## Introduction

Dengue, transmitted primarily by *Aedes aegypti* mosquitoes, is the most important mosquito-borne viral disease affecting humans worldwide [1]. It is caused by four serotypes that produce a spectrum of clinical illness ranging from unapparent or mild disease, to an influenza-like illness, to a fatal shock syndrome.

Due to the current lack of a licensed vaccine, dengue prevention is limited to vector control. *Aedes aegypti* control programs are based on two main targets: (1) the immature stages (egg, larvae, and pupae) through environmental management (source reduction), larvicides and/or biological control; and (2) the adult stage using space or residual sprays of chemical insecticides and more recently insecticide treated materials [2]. *Aedes aegypti* has strong associations with human habitations, living and breeding very near or inside human dwellings [3–5]. This extensive use of the human indoor environment poses challenges to traditional adult control methods and as well as in devising new or improved methods to sufficiently reduce disease transmission risk [6]. Pyrethroids have commonly been employed in dengue endemic countries such as Thailand and Peru for peridomestic and/or indoor residual/space-spraying to reduce adult mosquito populations [7,8]. However, despite the fact that selective use of pyrethroids and other residual insecticides applied indoors have successfully controlled *Ae. aegypti* and dengue [9–13], outdoor and peridomestic space-spraying alone has often failed to achieve any meaningful