Mekong Outdoor Malaria Transmission Network Meeting/Kasetsart University

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What are Spatial Repellents?
Product Description and Paradigm Claim

• Spatial repellents are products designed to release volatile chemicals into the air and prevent human-vector contact within the treated space.

Deployment of spatial repellent products in enclosed and semi-enclosed spaces will reduce pathogen transmission.
How Spatial Repellents are Expected to Function
Mechanism of Action

SPATIAL REPELLENCY
Prevention of human/vector contact

Spatial repellents elicit ‘spatial repellency’ which refers to a range of insect behaviors induced by airborne chemicals.

MOVEMENT AWAY prevent entry

ATTRACTION-INHIBITION interfere with host detection

FEEDING INHIBITION interfere with biting

Graphic by Kristina Davis
Role of Spatial Repellents in Outdoor/Residual Transmission

Filling Gaps

- **Addresses vector behavior variability**
  - day-time, early evening and/or outdoor biting

- **Facilitate coverage and reduce delivery challenges**
  - adding a consumer product distribution model (uptake enhancement)
  - top-down delivery during epidemics (dengue) and/or routinely (malaria)
  - less bulky than LLINs, IRS and/or space-spraying

- **Tools for insecticide resistance mitigation**
  - additional target sites, mode of action & functional doses beyond toxicity

- *New paradigm to drive R&D for novel chemical actives/products*
Role of Spatial Repellents in Outdoor/Residual Transmission
Applicable to Varied Lifestyles/Housing
Role of Spatial Repellents in Outdoor/Residual Transmission Facilitate Coverage

**Bottom-Up Approach**

A new paradigm for control should include focused surveillance and development and testing of products that appeal to the consumer; this could make national programs more effective and cheaper, and therefore more attractive.
Role of Spatial Repellents in Outdoor/Residual Transmission
Facilitate Distribution

**Top-Down Approach**

- Minimal bulk in packaging
- Target reservoirs of infection or high-risk groups
- Augment government sponsored campaigns – *WHO Technical Element #3 – Sustained Vector Control*

*Staff and patients, Mario Catarino Rivas hospital, San Pedro Sula, Honduras*
Evidence of Spatial Repellents to Prevent Disease

Coils alone: 77% PE  
LLINs alone: 91% PE  
Coils + LLIN: 94% PE  

Coils alone: 52% PE  
32% lower outdoor landing in houses with SR
Effects of the spatial repellent metofluthrin on landing rates of outdoor biting anophelines in Cambodia, Southeast Asia

J. D. CHARLWOOD, S. NENHEP, N. PROTOPOPOFF, S. SOVANNAROTH, J. C. MORGAN, J. HEMINGWAY

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• Metofluthrin
• Landing rates reduced by
  – 48% - 1 emanator
  – 67% - 4 emanators

• Similar results with tent traps and Cl

• Different results in Pailin, Pursat versus Koh Kong (no difference)
Modified mosquito landing boxes dispensing transfluthrin provide effective protection against *Anopheles arabiensis* mosquitoes under simulated outdoor conditions in a semi-field system

Marta Andres\(^1,2\), Lena M Lorenz\(^2,3\), Edgar Mbeleya\(^3\) and Sarah J Moore\(^3,4,5\)*

- Modified odor baited trap used with repellant
- Transfluthrin
- 69% protection against bites / landing
Efficacy of topical mosquito repellent (picaridin) plus long-lasting insecticidal nets versus long-lasting insecticidal nets alone for control of malaria: a cluster randomised controlled trial

Vincent Skythin, Lies Dumee, Samony Heng, Charlotte Goyseels, Lydia Carrier, Soarin Kin, Karel Van Rijey, Karen Kerkhofs, Namol Lim, Sokrati Mao, Samiruuk Ojk, Sil Savannarak, Ken Petersens Grieters, Tho Sopanghka, Didier Menard, Marc Coosemans

- Did not contribute to a decrease in malaria in a pre-elimination setting
- Attributed to lack of daily compliance and proper use (only 8% used versus 70% reporting use)
- Personal protection from mosquito bites versus protection from disease incidence (meta-analysis - Lindsay)

A new perspective on the application of mosquito repellents

Sarah Jane Moore
Swiss Tropical and Public Health Institute, Basel CH-4002, Switzerland; University of Basel, Basel, Switzerland; and Ifakara Health Institute, Bagamoyo, Pwani, Tanzania
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“Distribution of effective personal protection tools does not translate into personal or community protection with suboptimal compliance”
Several studies to demonstrate Push-pull strategies might be useful.

Chareonviriyaphap, Achee, Greico, Takken, Moore, Maia, etc.
Evidence of Spatial Repellents to Prevent Disease – Indoor Use

*Semi-enclosed space*
Engaging Global Stakeholders Early
Informed Decision-Making

• Initial work with WHO:
  – WHOPES panel discussion October 2010
  – Guidelines for Evaluation of Spatial Repellent Products
    http://www.who.int/whopes/resources/en

• Formal interactions with WHO and other experts to
  gather input into study design for proof-of-principle:
  – VCAG
  – IVCC ESAC
Guidance on Operational Implementation
Primary VCAG Topics

• What is the product coverage required for protection?

• **How does efficacy vary** with geography or vector bionomics?

• Do repellents have either a **diversion or a community-wide protection effect**?

• Are current pyrethroid-based repellents **effective against resistant vector populations**?

*Protective efficacy of spatial repellents outdoors must be demonstrated if it is to be included in paradigm*
Newly Funded Research Program (2014-2018)
Generating an Evidence Base

• **GOAL:**
  - Evaluate the public health impact of one spatial repellent product to reduce and prevent transmission of *Plasmodium* spp. and dengue viruses.

• **OBJECTIVES:**
  - Provide a quantitative estimate of protective efficacy (PE)
  - Provide inputs into program-relevant questions of optimization/application
  - Confirm and measure the entomological correlates of reduced infection
  - Drive efforts to acquire full recommendation of spatial repellent products
GOAL: Evaluate the public health impact of one spatial repellent product to reduce and prevent transmission of *Plasmodium* spp. and dengue viruses.
Key Program Updates

• Scale-back from Africa sites (Zambia, Tanzania, Kenya)
  o Team notified Mar 2016 - funder directed
  o All sites will be closed down by Dec 2016

• Indonesia (malaria):
  o Follow-up of 1,240 subjects (from 2,719 enrolled households) began May 2016.
    Approx. 9,000 blood spots have been collected as of Oct 2016.
  o 672 HLC collections (14x each at 4 sentinel sites in 12 clusters) have occurred
    following intervention as of Oct 2016, representing approx. 5,400 mosquito
    samples of varied species.

• Peru (dengue):
  o Weekly febrile surveillance in 13,674 persons for active virus infection has
    occurred as of Oct 2016.
  o Baseline samples from 1,225 subjects for longitudinal seroconversion have been
    collected as of Oct 2016.
Thank you

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Nicole achee (nachee@nd.edu)
What is the Effective Concentration of a Spatial Repellent?  
Primary WHOPES Topic