The effectiveness of topical repellent as additional tool to Long-Lasting Insecticidal Treated Nets on the mosquito populations in Cambodia

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Malaria in Cambodia

- **Decrease from 2009 to 2015**
  - Confirmed case ↘ 57%
  - Severe case ↘ 75%
  - Mortality ↘ 97%
- Endemic along borders
- *P*. *vivax* > *P*. *falciparum*
- *An. dirus*, *An. minimus*: primary malaria vectors

Elimination and Challenges

By 2020*:
- < 1 infection per 1000 people at risk.
- *P. falciparum* eliminated including multidrug resistant.

* National Strategic Plan for Elimination of Malaria in Cambodia 2011-2025
Topical repellent (Picaridin)

- 95% personal protection
  (Van Roey, Mao Sokny et al. 2014
   PloS Negl Trop Dis 8: e3326)

Topical repellent + LLINs* => Community protection ??

* LLINs= Long-Lasting Insecticidal Treated Nets
MalaResT project

*collaboration between CNM_ITM*

*financial supported by Bill & Melinda Gate foundation*

**Objective:** To evaluate the effectiveness of mass use of effective and safe topical repellent(s) (Picaridin 10% and 20%) in addition to LLINs in controlling malaria infections in Northeastern of Cambodia.

- 2 years project 2012-2013
- Randomized Control Trial of 98 clusters of 113 villages
- Epidemiological, anthropological and **entomological** outcomes studied.
General objective of entomological outcomes

To explore the impact of mass use of repellent on the occurrence and dynamics of malaria and arbovirus vector species in a forested area of Cambodia.
**Studied sites**

- **2 Years (2012-13)** in 4 villages
  - 2 intervention (LLINs + topical repellent)
  - 2 control (LLINs alone)
Mosquito collection

- 4 surveys / year / village
- Survey: 10 nights / 7 OHL (outdoor human landing collection)
- Time: 5-10 pm; 5-8am
- Collectors trained; repellent free (intervention villages)
Main outcomes

- **Vector density** expressed by bites / man / 10 days
- **Parity rates** as indicator of vector longevity, main element of Vectorial Capacity

=> Intervention (repellent + LLINs) vs control (LLINs) villages

* Number of parous mosquito / total number mosquito identified for parity status
Analysis

Diversity
in Microsoft Excel 2010

- Distribution of *Anopheles* species in the studied villages.
- Seasonal fluctuation and hour biting rate analyzed only for main malaria vectors*.

Repellent effect
In R program

- Hypothesis: Impact of repellent => \( \downarrow \) Density and Parity rate in intervention villages from year 1 to year 2 more than the ones’ in control villages.
- Four genera** and 4 main malaria vectors* analyzed.
- Negative binomial regression (density) and logistic regression (parity rate) were used.

* Main malaria vectors: *An. dirus*, *An. minimus*, *An. barbirostris*, *An. maculatus*.

** Genus: *Anopheles, Aedes, Mansonia, Culex*
Diversity of mosquitoes

• 2,240 person-nights collections / 2 years
• 41,417 mosquitoes collected (10% *Anopheles*)
• 24 *Anopheles* species:


*main malaria vectors. No* potential malaria vector including zoophilic vectors
Early biting vectors confirmed

![Graph showing man biting density by hour for different malaria vectors.](image)

- **Man biting density by hour of main malaria vector**

  - **An. barbirostris** (N=270)
  - **An. dirus** (N=174)
  - **An. maculatus** (N=1021)
  - **An. minimus** (N=147)

Note: Mosquitoes collected from 17h-22h and 5h-8h, 7 collectors outdoor per night for 8 surveys (10 days/survey) in 2012-2013.
Density of genus

Negative binomial regression as vector’s density was a discrete count data
Control and Year 1 were reference group in the model
Random variables: month/ village/ house position
Density of main malaria vectors

* P. value < 0.05 for interaction year - treatment

Negative binomial regression model as vector’s density was a discrete count data
Control and Year 1 were reference group in the model.
Random variables: month/ village/ house position
Parity rate

Logistic regression model as parity result was binary outcome (parous vs nulli-parous)
Control and Year 1 were reference group in the model
Repellent effect

Confirmation of the early outdoor biting of malaria vectors. New vector control tools needed (limitation of ITNs and IRS).

Effect of repellent on reduction of densities of Anopheles, Mansonia and Aedes, but not on Culex, and reduction on An. barbirostris, An. maculatus.

Lack of evidence of repellent effect on reduction of densities and parity rate on primary malaria vectors => Not sufficient to reduce malaria incidence*.

* article of Vincent Sluydts 2016, the Lancet.inf.dis.
Diversity of mosquitoes

The main malaria vectors went down comparing to 10 years ago.

<table>
<thead>
<tr>
<th>Species</th>
<th>This study</th>
<th>2005 (Durnez et al. 2013)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>An. dirus s.l.</td>
<td>4%</td>
<td>10%</td>
</tr>
<tr>
<td>An. minimus s.l.</td>
<td>3%</td>
<td>25%</td>
</tr>
<tr>
<td>An. maculatus s.l.</td>
<td>21%</td>
<td>33%</td>
</tr>
<tr>
<td>An. barbirostris s.l.</td>
<td>6%</td>
<td>15%</td>
</tr>
<tr>
<td>Other species</td>
<td>66%</td>
<td>17%</td>
</tr>
</tbody>
</table>

* Study in forest area 2005 including the 2 districts studied from MalaResT

Role of zoophilic mosquitoes??
- Challenging to show impact of repellent on the transmission due to a complex situation: heterogeneity of humans, vectors and transmission.

- An impact of repellent on malaria vectors although not for primary vectors on reduction of density and parity rate.

- Repellent might be useful for migrant worker such rubber plantation workers, forest goer, police and soldiers at the borders of the countries.
Thank you for your listening