OUTDOOR AND EARLY HUMAN-VECTOR CONTACT: A CHALLENGE FOR MALARIA ELIMINATION IN LATIN AMERICA

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SITUATION OF MALARIA IN LATIN AMERICA
Situation of Malaria in the Region of the Americas, 2000-2012

Malaria morbidity and mortality, 2000 - 2012

People protected by indoor residual spraying and insecticide treated bednets, 2000 - 2012

COUNTRIES IN PRE-ELIMINATION PHASE
Main Malaria control strategies

IRS and LLINs, besides prompt Diagnostic and Treatment
Larvicides in some scenarios – poor evaluation of the efficacy
**HUMAN – VECTOR CONTACT**

**PROPORTION OF MOSQUITOS *Anopheles* CAUGHT INDOORS AND OUTDOORS BY HLC**

Latin American ICEMR - LONGITUDINAL STUDY 2012 - 2013

<table>
<thead>
<tr>
<th>Location</th>
<th>An.calderoni</th>
<th>An.albimanus</th>
<th>An.darlingi</th>
<th>An.nuneztovari</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAL B-Prieta</td>
<td>70%</td>
<td>63.5%</td>
<td>57.4%</td>
<td>53.3%</td>
</tr>
<tr>
<td>ABM P-Soldado</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AYM Robles</td>
<td></td>
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<td></td>
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<tr>
<td>AYM N-Union</td>
<td></td>
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<tr>
<td>DAR N-Union</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>TIV El Loro</td>
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<tr>
<td>TIV Tuis-Tuis</td>
<td></td>
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</tr>
<tr>
<td>TIV N-Union</td>
<td></td>
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</tr>
</tbody>
</table>

Outdoor: 70% | 63.5% | 57.4% | 53.3%
Indoor-outdoor *Anopheles darlingi* collections in 2013 in the Peruvian Amazon – Amazons ICEMR

25% Indoors; 75% outdoors

Conn, Moreno, et.al, in prep.
Morphological identification of mosquito specimens from barrier screens (2013)

<table>
<thead>
<tr>
<th>Locality</th>
<th>Species id</th>
<th>N (females/males)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lupuna (LUP)</td>
<td><em>An. darlingi</em></td>
<td>254 (246/8)</td>
</tr>
<tr>
<td></td>
<td><em>Cx. quinquefasciatus</em></td>
<td>60 (51/9)</td>
</tr>
<tr>
<td></td>
<td><em>Ma. indubitans/titillans</em></td>
<td>5 (4/1)</td>
</tr>
<tr>
<td></td>
<td><em>Ps. cingulata</em></td>
<td>2 (2/0)</td>
</tr>
<tr>
<td></td>
<td><em>An. forattini</em></td>
<td>1 (1/0)</td>
</tr>
<tr>
<td>Cahuide (CAH)</td>
<td><em>An. darlingi</em></td>
<td>316 (304/12)</td>
</tr>
<tr>
<td></td>
<td><em>Cx. quinquefasciatus</em></td>
<td>101 (63/38)</td>
</tr>
<tr>
<td></td>
<td><em>Ma. indubitans/titillans</em></td>
<td>72 (72/0)</td>
</tr>
<tr>
<td></td>
<td><em>Ma. humeralis</em></td>
<td>15 (15/0)</td>
</tr>
<tr>
<td></td>
<td><em>Cx. coronator</em></td>
<td>6 (3/3)</td>
</tr>
<tr>
<td></td>
<td><em>Cx. declarator</em></td>
<td>1 (1/0)</td>
</tr>
<tr>
<td></td>
<td><em>Cx. theobaldi</em></td>
<td>3 (3/0)</td>
</tr>
</tbody>
</table>

- *An. darlingi* is the most abundant species collected
- 77% (LUP) and 75% (CAH) of blood fed females were collected from the village side of the screen versus forest or river side.

An. darlingi blood meal identification from barrier screens (2013)
(Kent & Norris, 2005; Ngo & Kramer, 2003)
(N=277)

- HBI LUP: 0.72
- HBI CAH: 0.58

Amazons ICEMR results
Conn, Moreno, et.al, in prep.
HUMAN-VECTOR CONTACT AND SLEEPING PATTERNS OF THE POPULATION IN LATIN AMERICA

Hourly biting pattern of *Anopheles nuneztovari*, *An. albimanus*, *An. calderoni* and *An. darlingi* occurring both indoors (solid lines) and outdoors (dashed lines) at different study sites. The grey area represents the proportion of the human population predominantly spending time indoors and sleeping, during the times shown on the abscissa of each graph.

Quinones et al., in preparation
Quantification of the human-vector exposure while people is sleeping, and before going to sleep under a LLTN in Colombia

\[ B_{u,t} = B_{o,t} (1-S_t) + B_{u,t} S_t \]

mean biting rate experienced by an unprotected individual at each time of the night \(t\)

\[ \pi_S = \frac{\sum_{t=5 \text{ am}}^{24 \text{ pm}} B_{u,t}}{\sum_{t=1}^{24} B_{u,t}} \]

the proportion of human exposure during which an ITN would be in use

Killeen et.al, BMC Infectious Diseases 2006, 6:161

- Estimate amount of human-vector contact indoors, while sleeping
- Estimate amount of human-vector contact outdoors, and indoors before or after sleeping.

An overall of 66% of the bites could be protected by LLTNs

\( \approx 40\% \) unprotected

Quinones et.al, in preparation
HABITS OF THE POPULATION AT DUSK AND EARLY NIGHT

Photos of J.Escobar, Iscuandé, Nariño - Colombia
Most common breeding sites in the study area in Colombia

Cordoba

Valle

Nariño

Ahumada et.al, in preparation
“Bromeliad – Malaria”
In LA

Larval habitats of species of the Subgenus *Kerteszia*

HUMAN – VECTOR CONTACT

VECTOR SPECIES OF THE SUBGENUS KERTESZIA
A CHALLENGE FOR CONTROL

Human – vector contact of *An. (Kertezsia) neivai* in Nariño, Colombia

Indoors

Outdoors

Human – vector contact of *An. (Kertezsia) pholidotus* in Tolima, Colombia

Escobar, et.al, Mem. Osw. Cruz, 2013
HUMAN – VECTOR CONTACT
DURING FISHING ACTIVITIES IN CANOES

Escobar, et.al, Mem. Osw. Cruz, 2013
Present malaria control interventions and strategies are not enough for LA, complementary strategies are needed.

Evaluation under local LA conditions is necessary for complementary control measures.

**RESEARCH**: 2 ICEMR (International Centers of Excellence for Malaria Research – NIH Program) Latin America and Amazons.

**PILOT EVALUATIONS:**
- Southeast Asia ICEMR developed slow release blocks for *Bti/B.sphaericus* mix for larval control. Pilot evaluation in Colombia, in settings with wells as *An. albimanus* breeding sites.
- ATSB (Attractive toxic sugar baits) for LA vectors. Pilot as proof of concept in LA.
Initiative to Eliminate Malaria in Mesoamerica and the Island of Espanola (EMMIE)

Goal: to achieve elimination by 2020

Elements of the EMMIE initiative include:

- Supporting the standardization of case management best practice for malaria, to ensure **proper diagnosis and timely treatment**
- Supporting the standardization of an agreed protocol for **integrated vector management**
- Facilitating cross-border cooperation and **regional coordination**
- Establishing a regional **operational research framework** for guiding and facilitating the implementation of elimination strategies
SOME CONCLUDING REMARKS

- Tendency for an early and outdoor biting behavior of the malaria vectors in Latin America, together with the habits of the human communities – a challenge for malaria control or elimination.

- Larval habitats are usually far away from houses, difficult to reach, often human-made (to rear fish, to provide water, etc.), difficult to eliminate.

- Local research is needed, as well as evaluation of possible strategies, besides the main malaria vector control measures IRS or LLINs.