EXPANDING THE VECTOR CONTROL TOOLBOX: GAPS AND OPPORTUNITIES

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We set out to understand the gaps in the vector control landscape beyond ITNs and IRS and identify potential solutions to accelerate progress to elimination.

<table>
<thead>
<tr>
<th>Method</th>
<th>Question</th>
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<tbody>
<tr>
<td>Geospatial modeling</td>
<td>What is the extent of residual transmission?</td>
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<tr>
<td>Systematic literature review</td>
<td>What evidence exists to date and what gaps in evidence remain?</td>
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<tr>
<td>Aerial application technical review</td>
<td>What is the potential for aerial spraying for <em>Anopheles</em> control?</td>
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<tr>
<td>Transmission modeling</td>
<td>What are the optimal combinations of tools?</td>
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<tr>
<td>Case study series</td>
<td>What are enabling factors for implementation of new tools?</td>
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</table>
Transmission is estimated to persist even in areas with high bednet coverage in Sub-Saharan Africa

How can we better leverage the full toolbox of vector control tools and the mosquito lifecycle to address residual transmission?
Landscaping the literature

Objective: To identify options for expanding the malaria vector control toolbox to supplement ITNs and IRS, we conducted a systematic review of the availability and quality of the evidence for 21 malaria VCTs, excluding ITNs and IRS.

Systematically collate evidence of 21 VCTs

Establish the level of evidence (by study design) and stratify by outcome (when possible)

Identify gaps and opportunities for research to expand the evidence base
Systematic literature review methods

1. Search strategy
2. Eligibility assessment
3. Data abstraction
4. Risk of bias assessments
Inclusion criteria

Study designs

- Systematic reviews
- **Experimental studies**: Phase III (RCTs, CBA, COS, ITS), Phase II (small-scale, semi-field, experimental hut), and Phase I laboratory
- **Observational studies**: case-control, cohort, and cross-sectional studies

Outcomes

- **Primary**:
  - Incidence of confirmed clinical malaria
  - Parasite prevalence
  - Entomological inoculation rate (EIR)
  - Human biting rate (HBR)
  - Density measures other than the HBR
- **Secondary**:
  - Adult mosquito fecundity or fitness, adult emergence rates, knockdown post-exposure, and blood-feeding inhibition
Search results

17,912 abstracts identified through electronic database and hand searches

847 full-texts assessed for eligibility

155 studies eligible for inclusion in the qualitative synthesis
Across 21 vector control tools, only 7 have gone through a Phase III evaluation.
We also explored alternative application methods including aerial spraying

<table>
<thead>
<tr>
<th></th>
<th>Number of spray aircraft available on continent</th>
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<tbody>
<tr>
<td>Africa</td>
<td>200</td>
</tr>
<tr>
<td>South America</td>
<td>3,800</td>
</tr>
<tr>
<td>Asia-Pacific / Australia</td>
<td>1,400</td>
</tr>
</tbody>
</table>

- Aerial larviciding by helicopter in West Africa to control blackflies for onchocerciasis
- Aerial larviciding by fixed-wing aircraft in Brazil
- Yamaha R-Max, UAV for agricultural use
- Fleet for Tsetse fly control (adulticiding) in Africa
Transmission models are under development to estimate optimal intervention packages and design field tests.

Vector Control Optimization Model (VCOM); Kiware, S. et al (2017) In preparation

The right tools at the right time in the right place ultimately hinges on the readiness of the system

Best practices from case study series across the U.S., Australia, and malaria endemic countries:

- Entomological and operational capacity
- Entomological intelligence linked with spatial, epidemiological, and cost data
- Evidence-based and decentralized decision making
- Sustainable financing, often domestic
- Meaningful community engagement
- Strong leadership and management at all levels
- Link with research institutions
Ongoing development of shortlist of “ready” tools with potential for impact

<table>
<thead>
<tr>
<th>VCT shortlist based on “readiness” and potential for impact</th>
<th>Readiness for learning-by-doing</th>
<th>Target mosquito life stage</th>
<th>Target blood feeding preference</th>
<th>Target biting and resting behavior</th>
<th>Interest by programs surveyed?</th>
<th>Long-lasting intervention?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental management</td>
<td>![Green Circle] (now)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
<td>![Yes]</td>
</tr>
<tr>
<td>Larviciding (manual and aerial application)</td>
<td>![Green Circle] (now)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
<td>![Yes]</td>
</tr>
<tr>
<td>Mosquito-proofed housing</td>
<td>![Green Circle] (now)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
<td>![Yes]</td>
</tr>
<tr>
<td>Attract-and-kill not based on sugar</td>
<td>![Orange Circle] (1-2 years)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
<td>![Yes]</td>
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<tr>
<td>Attractive toxic sugar baits</td>
<td>![Orange Circle] (1-2 years)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
<td>![Yes]</td>
</tr>
<tr>
<td>Insecticide treated hammocks</td>
<td>![Orange Circle] (1-2 years)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
<td>![Yes]</td>
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<tr>
<td>Livestock endectocides</td>
<td>![Orange Circle] (1-2 years)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
<td>![Yes]</td>
</tr>
<tr>
<td>Space spray (ground-based and aerial)</td>
<td>![Orange Circle] (1-2 years)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
<td>![Yes]</td>
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<tr>
<td>Spatial repellents</td>
<td>![Orange Circle] (1-2 years)</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Checkmark]</td>
<td>![Yes]</td>
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How can we move beyond traditional research and explore a “learning-by-doing” approach
Opportunities for consideration by the RBM VCWG New Tools New Challenges workstream

• Develop a learning-by-doing research agenda on emerging novel vector control tools
  – Answer feasibility, scale, and cost-effectiveness questions
  – Test intervention packages, including drug-based strategies
  – Leverage new technology to strengthen vector surveillance for improved targeting, monitoring, and strategy iteration
  – Develop standardized indicators for evaluation of new tools

• Track studies on new tools
Acknowledgements

UCSF Global Health Group
Roly Gosling
Richard Feachem
Alemayehu Midekisa
David Savory
Gretchen Newby
Ricardo Andrade Pacheco
Shannon Brunner
Sophia Hocini
Yasmin Williams
Adam Bennett
Hugh Sturrock
Nicolas Simon
Germaine Kabutaulaka

UCSF/PMI
Jimee Hwang

Ifakara Health Institute
Samson Kiware
Fredros Okumu

Innovative Vector Control Consortium
Dave Malone

Institute for Health Metrics and Evaluation
David Smith

James Cook University
Patricia Graves

Liverpool School of Tropical Medicine/Ifakara Health Institute
Gerry Killeen

London School of Hygiene and Tropical Medicine
Immo Kleinschmidt

Malaria Atlas Project / University of Oxford
Pete Gething
Lucy Tusting

Manatee County Mosquito Control District
Mark Latham

Micron Group
John Clayton

Swiss Tropical and Public Health Institute
Nakul Chitnis

Tecnológico de Monterrey
Héctor Sánchez C

University of California, Berkeley
John Marshall
Sean Wu
The UCSF Global Health Group’s Malaria Elimination Initiative (MEI) accelerates progress towards malaria elimination in countries and regions that are paving the way for global malaria eradication.

http://www.shrinkingthemalariamap.org/what-we-do/vector-control