MALARIA VECTOR CONTROL RESEARCH AGENDA

February 3rd 2016

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Malaria (Vector Control)
Global Health Program
A HIGH LEVEL STRATEGY TO ERADICATE MALARIA

1) Detect the parasite
2) Eliminate the parasite from its reservoir
3) Prevent transmission of the parasite

Assumptions:
- New tools (Diagnostics, Chemotherapeutics, Vaccines, Vector Control) will be required over the course of the campaign in eco-epidemiologically appropriate configurations
- No single tool or activity by itself is the solution- history tells us this!
- Effective coordination/integration of interventions (eg. MDA + VC) will be required to sustain gains and achieve elimination
- Management of re-introduction of parasites (and vectors?) is absolutely critical if eradication is to be achieved
SETTING TWO: FOUR ‘PREVENT TRANSMISSION’ PHASES

**Intelligence Gathering & Suppression Phase**
(at least one transmission cycle)

1. Develop entomological intelligence needed to target and optimize vector control interventions

   **Key Phase Challenge:** Entomological intelligence will not always be needed to start correct interventions, but it will be required to complete eradication

2a. **Lower Seasonality:** Reduce vector capacity to point where radical cure is feasible

2b. **Higher Seasonality:** Targeted interventions against remaining vector populations during the dry season

**Elimination Phase**
(eco-epidemiologically variable)

3a. **Lower drug emphasis:** Achieve elimination through vector control and existing T3 approaches

3b. **Higher drug emphasis:** Reduce number of MDAs required and compensate for coverage gaps

**Sustain Phase**
(ongoing)

4. Sustain population protection against re-emergence of malaria parasite

**Residual Transmission**

**Key Phase Challenge:** How to crash vector populations in extremely high transmission settings?

**Key Phase Challenge:** How to prevent transmission in the absence of population-level protection?

**Key Phase Challenge:** What is the appropriate mix of drug and vector control interventions in a given setting?

**Relative Vector Control Activity**

- Ongoing Test, Treat, Track
- Existing VC
- Entomological Intelligence
- Crash Vector Populations
- Eliminate
- Maintain Protection

Residual Transmission

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**PREVENT RESIDUAL TRANSMISSION IN SITUATIONS WHERE CURRENT SOLUTIONS ARE INSUFFICIENT**

### Address Residual Transmission

- New vector control tools and operational guidance are needed
- There are situations where we do not have effective tools, methods and delivery systems to prevent transmission. An annual entomological inoculation rate (EIR) of less than two infected bites per person per year is considered to be necessary to achieve elimination of the parasite reservoir using drug-based strategies.

<table>
<thead>
<tr>
<th>LLINs/IRS Ineffective/Inadequate, e.g. Outdoor Biting</th>
<th>When preferred methods (LLIN/IRS) provide inadequate protection against transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited Access to Populations</td>
<td>When access to populations at risk is limited by conflict, politics, or lack of transportation infrastructure</td>
</tr>
<tr>
<td>Current Interventions Not Cost Effective</td>
<td>When interventions are too cost inefficient vs. resources available to eliminate</td>
</tr>
</tbody>
</table>

### Principal Investments

- 1b. ATSBs
- 1d. Eave Tubes
- **1e. Gene Drive**
- 1f. New Als
- 1g. Project Nimbus
- 1h. IVCC Push-Pull
- 1i. Spatial Repellents
- 1j. GCE: Outdoor Transmission

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Current Investment  | Recommended Investment

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## WE NEED TO ANSWER QUESTIONS ABOUT MOSQUITO VECTORS TO PROCEED WITH EFFECTIVE CONTROL

<table>
<thead>
<tr>
<th>Fill Gaps in Understanding of Key Biology</th>
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<tbody>
<tr>
<td>▪ Basic science gaps need to be filled to eliminate malaria.</td>
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<tr>
<td>▪ There are places in the world where we do not know the vectors well enough to be able to measure risk</td>
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<table>
<thead>
<tr>
<th>Presence of unknown species</th>
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<tbody>
<tr>
<td>What species are present?</td>
<td>Species transmitting malaria and rate at which these species are transmitting (vectorial capacity)</td>
</tr>
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<table>
<thead>
<tr>
<th>Known vector, unknown vectorial capacity</th>
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<tbody>
<tr>
<td>The spatial and temporal location of important species</td>
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<table>
<thead>
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<th>Unknown location of important vector species</th>
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<td>To what extent and where are mosquitoes a reservoir of parasites during the dry season</td>
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### Principal Investments

<table>
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<th>3a. Vector Identification</th>
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<tr>
<td>3b. Parasite Reservoir</td>
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<tr>
<td>3c. Training</td>
</tr>
</tbody>
</table>
Vectorial capacity is determined by:
- A preference for human-biting (anthropophagic)
- Close association with human habitations (domestic, peridomestic)
- Competence to become infected and transmit malaria parasites

In Africa, this is the case with the *An. gambiae* and *funestus* species complexes.

Sub-Saharan Africa represents the malaria “heartland” where it is often not possible:
- to access populations in the rainy season, and
- where resources are not available or
- interventions are too costly for local populations to access.
WE MUST BE ABLE TO PREVENT MALARIA REINTRODUCTION FOLLOWING ELIMINATION

**Clear and Hold Ground**
- Better systems are needed to stop malaria reintroduction
- Following elimination in a given geographic area, we do not have adequate systems at scale to prevent reintroduction and to respond quickly to stop local outbreaks

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<th>Cannot deliver emergency interventions</th>
<th>We cannot provide adequate emergency response systems where they will be needed</th>
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<tr>
<td>Cannot sustain low vector/population contact</td>
<td>We cannot create communities in which the abundance of vectors and their contact with humans are low</td>
</tr>
<tr>
<td>Cannot Identify areas prone to reintroduction</td>
<td>We cannot find out which areas are most susceptible to reintroduction after elimination</td>
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</tbody>
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Principal Investments
- 1b. ATSBs
- 1d. Eave Tubes
- 1e. Gene Drive
- 2a. Evidence-Based Vector Control
- 2c. Sustainment Convening
- 3a. Vector Identification

Current Investment  Recommended Investment
Address Insecticide Resistance

• Insecticide resistance is defined as a heritable genetic change in the mosquito genome, resulting in decreased susceptibility to an insecticide. This has unquestionably occurred in mosquito populations.

• The relationship between insecticide resistance and “operational success” or “operational failure” of vector control interventions is not well understood or well defined. There are many reasons for operational failure other than insecticide resistance.

• Current policy (GPIRM) advocates the rotation of insecticides used in IRS based on susceptibility testing of a discriminating dose, which may not be an optimal predictor of the need for change.
Evidence-based Vector Control (EBVC)

- We cannot always measure the location, abundance, and importance of vectors in ways that inform vector control operations for effective targeting and evaluation of interventions.

Cannot measure vector risk factors well

We cannot measure mosquito populations cheaply, with sufficient granularity, with the objective of getting accurate measures of abundance and infectivity.

Cannot measure risk information

We cannot gather information quickly and in a way that can be used at all levels of organization.

Cannot match intervention to needs

We cannot determine whether our planned interventions will have the desired effect on vector populations.

Principal Investments

1j. GCE: Outdoor Transmission

2a. Evidence-Based Vector Control

2c. Resistance Convening

3a. Vector Identification

3c. Training