Vector Control Strategies and Successes

... and challenges

Building on Success – Malaria Control and Elimination

Swiss TPH Winter Symposium 2016
Basel, Switzerland
Wide-spread deployment of core vector control tools

↑ ITN coverage

↓ IRS coverage

Source: World Malaria Report 2015
Massive increase in the number of ITNs delivered to endemic countries:
- 2004: 6 million
- 2015: 178 million

> 1 billion nets delivered worldwide 2004-2015

Figure 3.5 Proportion of the population protected by IRS or with access to ITNs in sub-Saharan Africa, 2014

↑ overall protection with vector control

Source: World Malaria Report 2015
Significant decline in burden across all regions

Figure 2.2 Percentage decrease in (a) estimated malaria case incidence and (b) malaria death rate, by WHO region, 2000–2015

AFR, African Region; AMR, Region of the Americas; EMR, Eastern Mediterranean Region; EUR, European Region; SEAR, South-East Asia Region; WPR, Western Pacific Region

* There were no recorded deaths among indigenous cases in the WHO European Region for the years shown.

Source: WHO estimates

Source: World Malaria Report 2015
Major contribution of insecticidal vector control

- In sub-Saharan Africa, 70% of reductions were attributed to interventions; of this, 69% was attributed to ITNs, 21% to ACTS and 10% to IRS.

Source: World Malaria Report 2015
Numerous challenges remain

Funding gaps
- Current annual spending: US$ 2.7 billion
- Annual spending required by 2030: US$ 8.7 billion
- Financing will need to triple from current levels

Coverage gaps
- 1 in 4 children in sub-Saharan Africa still living in household without ≥1 ITN or IRS
- 60 million malaria cases undiagnosed & untreated
- 15 million pregnant women do not receive any IPTp
- Scale-up of core interventions must continue

Biological challenges
- *P. falciparum hrp2/3* gene deletions
- Antimalarial drug efficacy and insecticide resistance
- New and approaches tools are required to address challenges

In 2015:
- 214 million cases
- 438,000 deaths
- 3.2 billion at risk

Adapted from Alonso 08/12/2016
For vector control and entomology:

- Maximize the impact of current vector control interventions (LLINs and IRS – plus other supplementary measures)
- Maintain adequate entomological surveillance and monitoring - strengthen capacity for evidence-driven vector control
- Implement targeted vector control where transmission has declined
- Prevent and manage insecticide resistance and residual malaria parasite transmission
- Support the development and uptake of new tools (harness innovation)
- Improve quality control of vector control products

http://www.who.int/malaria/areas/global_technical_strategy/en/
Achieving and sustaining LLIN coverage essential

• Mass free LLIN distributions to at-risk populations continue to be necessary
  • Generally every 3 years (assuming routine systems are also functional)
  • In the absence of functional routine systems, campaigns should occur more frequently than every 3 years
  • Target 1 LLIN for every 2 persons (with procurement metric for campaigns of 1 LLIN for every 1.8 persons)
• ANC and EPI - highest priority channels for continuous distribution (before, during and after mass campaigns)

Are there situations in which reduction in coverage of vector control activities will not result in resurgent transmission?

1. In areas with ongoing local malaria transmission (irrespective of both the pre-intervention and the current level of transmission), the scale-back of vector control is not recommended. Universal coverage with effective malaria vector control should be pursued and maintained.

2. In areas where transmission has been interrupted, the scale-back of vector control should be based on a detailed analysis that includes assessment of receptivity, vulnerability and disease surveillance coverage, and capacity for case management and vector-control response.

3. Countries and partners are therefore requested to invest in health systems particularly strengthening of disease and entomological surveillance, as identification of areas for geographical scale-back depends on the availability of this capacity.

Insecticide resistance threatens gains

- Resistance reported:
  - For 60 countries
  - For all major vectors
  - To all 4 insecticide classes

- GPIIRM – urgent efforts needed to ensure correct use of existing interventions and availability of new tools in order to **maintain the effectiveness of malaria vector control**

- But GPIIRM adoption to policy and operational implementation at country level have generally been poor due to a lack of political will coupled with major financial, human and infrastructural resource deficiencies

- No clear idea of resistance impact on intervention effectiveness
WHO-coordinated evaluation conducted 2009 – 2016 in Benin, Cameroon, India, Kenya and Sudan

Primary objectives

• To assess trends in insecticide resistance status and underlying mechanisms in main malaria vector species in response to different interventions.

• To determine the impact of insecticide resistance in malaria vectors on the protective effectiveness of LLINs and IRS, and therefore on malaria disease burden.
IR evaluation: study design and considerations

- Need for a common study design across all countries
- Need for standardisation of methods, outcomes and measurements
- Need for adequate statistical power, hence replication in many places (clusters)
- Design had to be observational since resistance cannot be randomly assigned

**Entomological indicators**
Insecticide susceptibility of main vectors (% mosquito mortality in WHO tube tests)

**Epidemiological endpoints**
- Active case detection in cluster cohorts
- Active infection detection in cluster cohorts
- Prevalence of infection in clusters
- Trends in insecticide resistance
- Effectiveness of nets (incidence in LLIN users versus non-users)
- Associations between resistance and morbidity

## IR evaluation: implementation sites

<table>
<thead>
<tr>
<th>EVALUATION AREAS</th>
<th>BENIN</th>
<th>CAMEROON</th>
<th>INDIA</th>
<th>KENYA</th>
<th>SUDAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region/s</td>
<td>Département de</td>
<td>North Region</td>
<td>Kondagaon,</td>
<td>Western Kenya</td>
<td>Gezira, Gedarif</td>
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<td></td>
<td>Plateau</td>
<td></td>
<td>Chhattisgarh</td>
<td>and Kassala States</td>
<td>and Khartoum States</td>
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<tr>
<td>Sub-region/s</td>
<td>Ifangni</td>
<td>Garoua</td>
<td>Keshkal</td>
<td>Bondo</td>
<td>El Hoosh</td>
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<td></td>
<td>Sakété</td>
<td>Mayo Oulo</td>
<td></td>
<td>Nyando</td>
<td>Galabat</td>
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<td></td>
<td>Pobé</td>
<td>Pitoa</td>
<td></td>
<td>Rachuonyo</td>
<td>Hag Abdalla</td>
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<td></td>
<td>Kétou</td>
<td></td>
<td></td>
<td>Teso</td>
<td>New Halfa</td>
</tr>
<tr>
<td>PIPR 2–10 endemicity class</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Baseline P. falciparum incidence</td>
<td>1.4 / year</td>
<td>0.6 / year</td>
<td>0.015 / year</td>
<td>1.4 / year</td>
<td>0.03 / year</td>
</tr>
<tr>
<td>Key vector/s</td>
<td>An. gambiae s.s.</td>
<td>An. arabiensis</td>
<td>An. culicifacies</td>
<td>An. gambiae s.s.</td>
<td>An. arabiensis</td>
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<tr>
<td></td>
<td>An. gambiae s.s.</td>
<td></td>
<td></td>
<td>An. arabiensis</td>
<td>An. funestus</td>
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<tr>
<td></td>
<td>An. coluzzii</td>
<td></td>
<td></td>
<td>An. gambiae s.s.</td>
<td>An. arabiensis</td>
</tr>
<tr>
<td>Baseline pyrethroid susceptibility</td>
<td>20–100%</td>
<td>43–100%</td>
<td>86–100%</td>
<td>1–100%</td>
<td>47–100%</td>
</tr>
</tbody>
</table>

### Evaluation design

<table>
<thead>
<tr>
<th>Number of clusters, by intervention</th>
<th>LLINs</th>
<th>LLINs + IRS</th>
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</thead>
<tbody>
<tr>
<td>Actual number of children in cohort, per cluster</td>
<td></td>
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</tr>
<tr>
<td>32</td>
<td>0</td>
<td>0</td>
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<tr>
<td>38</td>
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<td>50</td>
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<td>0</td>
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<tr>
<td>70</td>
<td>0</td>
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### Notes

- a proportion of 2–10 year olds in the general population that are infected with *P. falciparum*, averaged over the 12 months of 2010 as estimated by Malaria Atlas Project (MAP); low = 0% < PIPR 2–10 ≤ 5%; intermediate = 5% < PIPR 2–10 ≤ 40%; high = PIPR 2–10 > 40%;
- b mortality as measured in standard WHO susceptibility tests with the insecticide used in local LLINs;
- c IRS with deltamethrin and lambda-cyhalothrin in Rachuonyo and Nyando in 2012 only;
- d IRS with bendiocarb but with deltamethrin in Galabat in 2011 and 2012.
IR evaluation: outcomes

1. Insecticide resistance was highly variable between years and was heterogeneous on a relatively fine scale. There was a significant trend of increasing pyrethroid resistance in the main malaria vector species.

2. There was no evidence of an association between malaria disease burden and pyrethroid resistance across all locations.

3. There was evidence that LLINs provided personal protection against malaria in areas with pyrethroid resistance. There was no difference detected in LLIN effectiveness between higher and lower pyrethroid resistance.

4. There was evidence from an area (Galabat) with high LLIN coverage that IRS with an insecticide to which there is resistance provided no additional protection whereas IRS with an insecticide to which there is susceptibility almost halved malaria incidence relative to LLINs alone.

5. The development of pyrethroid resistance was slower in areas with LLINs plus a non-pyrethroid IRS than in an area with LLINs only.
• Universal coverage with effective vector control of all at-risk populations is essential to protect against malaria. LLINs continue to provide protection even in the face of resistance.

• Despite gains made against malaria, transmission is still occurring. New tools and strategies are required.

• Countries are urged to develop and implement national insecticide resistance monitoring and management plans.

• Better measures of insecticide resistance are needed.

Limited options for insecticide resistance management

**LLINs:**

*Now:* nets with pyrethroid or pyrethroid+synergist  
*In process:* nets with pyrethroid+other Al

**IRS:**

*Now:* formulations of pyrethroid, DDT, carbamate or organophosphate  
*In process:* formulations of other Al or pyrethroid+other Al (mixture)

➢ Multiple classes can be used in rotation or mosaics

**Combination of IRS and LLINs:**

*Now:* pyrethroid LLINs plus non-pyrethroid IRS can be used to manage resistance - but limited evidence that combining reduces malaria burden.  
➢ Programmes should focus on delivery of either IRS or LLINs at high coverage and high quality rather than adding to compensate in deficiencies of the first.

Recommendations (abbreviated)

- While PBO LLINs appear to have an increased efficacy in certain settings, the evidence is still limited to justify a complete switch from pyrethroid-only LLINs to PBO LLINs across all settings.
- PBO LLINs should be used only where universal coverage with effective vector control (LLINs and/or IRS) of populations at risk of malaria will not be reduced, as PBO LLINs may be more expensive than pyrethroid-only LLINs.
- In order to build the evidence base that would support accelerated deployment of PBO LLINs, pilot “exploratory” implementation is necessary.

Test procedures for monitoring resistance updated

- Supersedes the 2013 test procedures

- Updated to include:
  - **Diagnostic concentrations for additional insecticides** that may be used in vector control interventions
  - **Intensity assays** to measure the strength of the resistance in a mosquito population
  - **Synergist assays** that can operate as a proxy for metabolic mechanism involvement in resistance

Transmission that continues even with good access to LLINs or well-implemented IRS, or in situations where LLIN use or IRS implementation are not practical; due to a combination of human and mosquito behaviours.

Recommendations (abbreviated)

1. Generate local evidence on the magnitude of the problem of residual transmission of malaria
2. Develop new vector control tools to address residual transmission.
3. Ensure that registration processes support the rapid availability to the local market of validated new vector control products.

Strengthened capacity in public health entomology needed

- Ensure basic capacity of human and infrastructure to support vector control and entomological monitoring
- Establish/strengthen an intersectoral coordination mechanism, for developing a long-range strategic plan for building human resources and systems
- Conduct training needs assessments and curricula review for pre-service and in-service training (including epidemiology and management)
- Review, revise or establish posts and career development structures at all levels
- Ensure there are sufficient resources for human and infrastructure capacity-building factored into bi-lateral and multi-lateral projects and programmes, based on the established national strategic plan.

A comprehensive approach to vector control required

Draft global vector control response

- Effective locally-adaptive and sustainable vector control
- Reduce the burden and threat of vector-borne diseases that affect humans

Pillars of action:
- Strengthen inter- and intra-sectoral action and collaboration
- Enhance entomological surveillance and monitoring and evaluation
- Scale up and integrate tools and approaches
- Engage and mobilize communities

Foundation:
- Enhance vector control capacity
- Increase basic and applied research and innovation

Global Malaria Programme
Conclusions

*Malaria as “a problem to be solved – not simply a task to be performed”*

Vector control

- **Strategies:** are proven but require augmentation to achieve elimination
- **Successes:** are evident but much work remains to optimize implementation
- **Challenges:** are numerous but so too are opportunities to strengthen “problem solving” capacity and capability
Thank you

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