Framework for a national plan for monitoring and management of insecticide resistance in malaria vectors

Webinar

25 July 2017

Global Malaria Programme | World Health Organization
Insecticide resistance in malaria vectors

Resistance confirmed: 60 countries; all major vectors; all 4 insecticide classes
Outcomes from standard resistance bioassays, 2014-2017, by WHO region

Resistance detected across all regions and insecticide classes

Global Malaria Programme

Source: WHO insecticide resistance database
Resistance detected across all regions and insecticide classes

Outcomes from standard resistance bioassays, 2014-2017, by WHO region

CARBAMATES

- Confirmed resistance
- Possible resistance
- Susceptible

ORGANOPHOSPHATES

- Confirmed resistance
- Possible resistance
- Susceptible

Source: WHO insecticide resistance database
Insecticide resistance threatens to reverse recent gains in malaria control.

Urgent efforts should be taken to prevent the emergence and spread of resistance.

Countries are urged to develop and implement comprehensive insecticide resistance management strategies.

http://www.who.int/malaria/publications/atoz/gpirm/- released May 2012
Five pillars of GPIRM

**Short-term (~3 years)**
Preserve susceptibility and slow the spread of resistance on the basis of current knowledge, and reinforce monitoring capability and activities.

**Medium-term (3–10 years)**
Improve understanding of IR and tools to manage it, and adapt strategy for sustainable vector control accordingly.

**Long-term (≥10 years)**
Use innovative approaches for sustainable vector control at global scale.

1. Plan and implement insecticide resistance management strategies in malaria-endemic countries.
2. Ensure proper, timely entomological and resistance monitoring and effective data management.
3. Develop new, innovative vector control tools.
4. Fill gaps in knowledge on mechanisms of insecticide resistance and the impact of current insecticide resistance management strategies.
5. Ensure that enabling mechanisms (advocacy, human and financial resources) are in place.

IR, insecticide resistance

---

1 Including areas in which there is evidence of control failure, areas with significant resistance to pyrethroids, areas with a high malaria burden and intensive use of pyrethroid-based vector control interventions (so that control failure would have devastating consequences) or areas with unknown status of resistance.
Implications of insecticide resistance

WHO-coordinated multi-country 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.

Evaluation design

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

• 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.

• Impact on community effect was not measured and levels of resistance were moderate.

• Similar results were found from a study in Malawi (Lindblade et al. 2015)
Implications for vector control & surveillance

• 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, but transmission is still occurring. New tools and strategies are required to proceed to elimination.

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

• Better measures of insecticide resistance are needed that correlate with operational impact.

Main methods for monitoring resistance

WHO susceptibility test

CDC bottle bioassay
Updated test procedures for monitoring resistance

Test procedures for insecticide resistance monitoring in malaria vector mosquitoes
Second edition

It is essential to conduct insecticide resistance monitoring on at least an annual basis.

When resistance is detected, further investigations should be initiated to:

- Measure resistance intensity
- Identify resistance mechanisms

Based on this information, appropriate options to respond to emerging resistance can be identified and implemented.
Insecticide resistance management is essential

- Current options for resistance management are limited
- Ultimately, new tools as well as **new active ingredients** for both LLINs and IRS are needed for the management of insecticide resistance
<table>
<thead>
<tr>
<th><strong>LLINs</strong></th>
<th><strong>Combination of IRS and LLINs:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Now:</em> nets with pyrethroid or pyrethroid + synergist</td>
<td><em>Now:</em> pyrethroid LLINs plus non-pyrethroid IRS can be used to manage resistance - but limited evidence that combining reduces malaria burden.</td>
</tr>
<tr>
<td><em>In process:</em> nets with pyrethroid + other AI</td>
<td>✓ 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.</td>
</tr>
</tbody>
</table>

**IRS**

*Now:* formulations of pyrethroid, DDT, carbamate or organophosphate

*In process:* formulations of other AI or pyrethroid + other AI (mixture)

✓ Multiple classes can be used in rotation or mosaics
Defining the appropriate insecticide resistance management strategy for a given situation is **highly complex**, as it depends on multiple entomological, ecological, epidemiological and operational considerations.
Framework for IR monitoring and management

• Framework provides guidance to countries for developing national plans to monitor and manage insecticide resistance, and to assist in securing the required financial resources to conduct essential monitoring activities.

• Framework is adaptable and designed to help countries ensure adherence to the objectives and recommendations of the GPIRM.

http://www.who.int/malaria/publications/atoz/9789241512138/ - March 2017
How IRMMPs feed into NMSPs

**FIG. 1**

Simple graphical representation of how an IRMMP feeds into the national malaria strategic plan.
Key elements of an IRMMP

• **Executive summary** – a concise overview of the plan’s objectives, rationale, monitoring methodology and decision-making process.

• **Situational analysis** – provides an analytical review of relevant data on a country’s malaria situation.

• **Implementation framework** – states the criteria, structures and mechanisms to support implementation, as well as tasks, activities, human resources and budget.

• **Annual workplan** – includes annual tasks, timelines and budget.
A situational analysis should include summaries of the following:

- The country’s malaria epidemiology and current vector control interventions;
- Insecticide compounds and formulations registered and the amounts used;
- Malaria vector species that are present, their insecticide susceptibility status and their resistance mechanisms;
- Key evidence on malaria vector control and of any knowledge gaps;
- A list of the partners involved in insecticide resistance monitoring or management activities;
- Identification of risks, and of financial, human and other resource constraints that may impede implementation; and
- An indication of the measures in place to address the various challenges.
The **implementation framework** should include details on:

- **Monitoring**: criteria used to select established and proposed insecticide resistance monitoring sites; the mosquitoes to be targeted for testing and the procedures; the specific type or types of tests that will be used; data recording and reporting procedures; and a summary of procurement and supply schedules.

- **Management**: status and proposed membership of a decision-making body to coordinate national activities and ensure that any change in vector control policy or an IRMMP can be implemented effectively, including an outline of the process for interpretation of test results and their policy implications.

- **Additional information**: tasks, activities and timelines; human resource requirements; comprehensive budget and potential sources of funding; risks and how to address these.
### FIG. 7
**Example of a table outlining tasks, objectives, activities, body responsible and timelines**

<table>
<thead>
<tr>
<th>TASK</th>
<th>OBJECTIVES</th>
<th>ACTIVITY</th>
<th>RESPONSIBLE</th>
<th>YEAR 1</th>
<th>YEAR 2</th>
<th>YEAR 3</th>
<th>YEAR 4</th>
<th>YEAR 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capacity building</strong></td>
<td>To enable appropriate insecticide resistance monitoring and management through human and infrastructural capacity enhancement</td>
<td>Recruit necessary personnel to fill identified gap (followed by ongoing mentorship)</td>
<td>NMCP / partners</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conduct training of established and new personnel (followed by ongoing mentorship)</td>
<td>NMCP / partners</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improve laboratory and insectary facilities and procure necessary equipment</td>
<td>NMCP / research institute</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Insecticide resistance monitoring</strong></td>
<td>To conduct annual evaluations of insecticide resistance at all sentinel sites to support evidence-based decision-making</td>
<td>Establish sentinel sites</td>
<td>NMCP</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carry out field collections of larvae (or bloodfed adults as required)</td>
<td>NMCP</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rear larvae to adult mosquitoes in field insectary</td>
<td>NMCP</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conduct morphological species identifications (and using other techniques as required)</td>
<td>NMCP / research institute</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conduct bioassays with discriminating and intensity concentrations</td>
<td>NMCP</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conduct synergist-insecticide bioassays</td>
<td>NMCP</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enter data electronically into standard spreadsheet</td>
<td>NMCP</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Quality assurance and control</strong></td>
<td>To conduct periodic evaluations of vector control interventions at selected sites to support evidence-based decision-making</td>
<td>Develop and implement monitoring and evaluation plan for interventions (residual efficacy, durability)</td>
<td>NMCP / partner</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conduct monitoring and evaluation activities</td>
<td>NMCP / partner</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Enter data electronically into standard spreadsheet</td>
<td>NMCP / partner</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Data management and dissemination</strong></td>
<td>To streamline system for reporting of insecticide resistance monitoring as well as quality monitoring data</td>
<td>Develop standard national spreadsheets for data reporting, and disseminate to partners involved in data collection</td>
<td>NMCP / WHO</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Establish and maintain national insecticide resistance database</td>
<td>NMCP</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Global Malaria Programme
Next steps

• Countries developing IRMMPs should proceed to finalize and integrate these into existing national strategic plan for malaria.

• WHO are available to provide technical support for the development and implementation of these plans.

• Please contact country or regional offices, or gmp-ir@who.int for more information.