Insecticide Resistance – Databases and Global Status Update

Malaria Vector Control Unit

RBM Vector Control Working Group 10th Annual Meeting
Geneva, Switzerland
28 - 30 January 2015
### WHO Global Technical Strategy for Malaria, 2016 – 2030

**DRAFT GLOBAL TECHNICAL STRATEGY AT A GLANCE**

<table>
<thead>
<tr>
<th>Goals</th>
<th>Vision – A world free of malaria</th>
<th>Milestones</th>
<th>Targets</th>
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</thead>
<tbody>
<tr>
<td>1. Reduce malaria mortality rates globally compared with 2015</td>
<td></td>
<td>≥40%</td>
<td>≥90%</td>
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<tr>
<td>2. Reduce malaria case incidence globally compared with 2015</td>
<td></td>
<td>≥40%</td>
<td>≥90%</td>
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<tr>
<td>3. Eliminate malaria from countries in which malaria was transmitted in 2015</td>
<td>At least 10 countries</td>
<td>At least 20 countries</td>
<td>At least 35 countries</td>
</tr>
<tr>
<td>4. Prevent re-establishment of malaria in all countries that are malaria-free</td>
<td>Re-establishment prevented</td>
<td>Re-establishment prevented</td>
<td>Re-establishment prevented</td>
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</tbody>
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WHO Global Technical Strategy for Malaria, 2016 – 2030

MAJOR CHALLENGES ANTICIPATED

- Lack of robust, predictable, sustained international & domestic financing
- Drug resistance
- Insecticide resistance
- Residual transmission
- Hard-to-reach populations
- Lack of technical and human resources
- Weak surveillance systems
- Weak health systems
Global Plan for Insecticide Resistance Management in malaria vectors (GPIRM): a call to action

May 2012 - *If we take action now, we can stay ahead of the curve and maintain the fabulous gains that we have made.*
5-pillar strategy

**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 a global scale.

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**Five pillars of strategy**

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.
Databases
Insecticide resistance data: Reporting

DATA CONSOLIDATION (2000-2014)

National programmes

National database

Standard data forms

Regional database

Global database

Research and academia

Other partners eg. donors

Research and academia

Other partners eg. donors
Insecticide resistance data: Reporting

FEEDBACK

National programmes

National database

Validation

Standard data forms

Cleaning, Geo-referencing Verification

Regional database

Global database
Insecticide resistance data: Reporting

**OUTPUTS**

- National programmes
  - National database
  - Standard data forms
  - Regional database
  - Global database

- Detailed reports/maps of subnational data
- Automated data summary
- Automated map summary
- Regional summary profiles
- World Malaria Report
- Interactive global map
- Other: GHO, static maps
Entomological Capacity: Reporting

PARALLEL PROCESS

National programmes

Standard data forms

Global capacity assessment
## Insecticide resistance data*: Reporting status

### Countries with Data

Data available for 81 countries.

Verification process ongoing.

*WHO susceptibility tests and CDC bottle bioassays

### Countries by Region

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<thead>
<tr>
<th>Africa</th>
<th>E. Mediterranean</th>
<th>Europe</th>
<th>Americas</th>
<th>South East Asia</th>
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### Data Status

- **No data received**
- **Confirmed that there are no data available (2000-2013)**
- **Confirmed that there are no data available (2011-2013)**
- **Feedback / confirmation pending**
- **Data finalised**
### Entomological Capacity: Reporting status

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**Data reported for 63 countries**

**Data finalised for 48 countries – verification ongoing**

- No report received
- Incomplete
- Finalised
# Global Insecticide Resistance Database: overview

<table>
<thead>
<tr>
<th>REPORTED DATA</th>
<th>FILTERED DATA (STANDARD INSECT. + DOSE)</th>
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</thead>
<tbody>
<tr>
<td><strong>Years</strong></td>
<td>1947 - 2014</td>
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<tr>
<td><strong>Countries</strong></td>
<td>81</td>
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<tr>
<td><strong>Localities</strong></td>
<td>2090</td>
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<tr>
<td><strong>Vector species names</strong></td>
<td>105</td>
</tr>
<tr>
<td><strong>Insecticides + doses</strong></td>
<td>189</td>
</tr>
<tr>
<td><strong>TOTAL BIOASSAY DATA POINTS</strong></td>
<td><strong>13,533</strong></td>
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<td>(95.4% tube tests, 4.6% bottle bioassays)</td>
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<tr>
<td><strong>Mechanism types</strong></td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL MECHANISMS DATA POINTS</strong></td>
<td><strong>768</strong></td>
</tr>
</tbody>
</table>
Global Status Update
Insecticide resistance: data reported for 64 countries since 2010

Reported insecticide susceptibility status for malaria vectors (2010-2014)

Where multiple insecticide classes or types, mosquito species or time points were tested, the highest resistance status is shown.

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Malaria Report 2014
Map Production: Global Malaria Programme
World Health Organization
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National IR monitoring & management plans: completed for 10 countries

Status of national insecticide resistance monitoring and management plan (2014)

Resistance management plan status
- Completed
- Not reported
- Under development
- No ongoing malaria transmission
- Not commenced
- Not applicable

Where multiple insecticide classes or types, mosquito species or time points were tested, the highest resistance status is shown.

The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted and dashed lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Malaria Report 2014
Map Production: Global Malaria Programme
World Health Organization

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Many countries with resistance do not yet have IRM plans – especially outside of Africa

Reported insecticide susceptibility status for malaria vectors (2010-2014) and status of national insecticide resistance monitoring and management plan (2014)

Resistance status Resistance management plan status
- Confirmed  Completed  Not reported
- Possible: to be confirmed  Under development  No ongoing malaria transmission
- Susceptible  Not commenced  Not applicable

Where multiple insecticide classes or types, mosquito species or time points were tested, the highest resistance status is shown.

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Data Source: World Malaria Report 2014
Map Production: Global Malaria Programme
World Health Organization
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Pyrethroid resistance: 45 countries and 58% of surveyed sites

Reported pyrethroid susceptibility status for malaria vectors (2010-2014)

Where multiple insecticide classes or types, mosquito species or time points were tested, the highest resistance status is shown.

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Data Source: World Malaria Report 2014
Map Production: Global Malaria Programme
World Health Organization
Organochlorine resistance:
36 countries and 60% of surveyed sites

Reported organochlorine susceptibility status for malaria vectors (2010-2014)

Where multiple insecticide classes or types, mosquito species or time points were tested, the highest resistance status is shown.

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Data Source: World Malaria Report 2014
Map Production: Global Malaria Programme
World Health Organization

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Carbamate resistance: 29 countries and 29% of surveyed sites

Reported carbamate susceptibility status for malaria vectors (2010-2014)

Resistance status
- Red: Resistance
- Yellow: Possible: to be confirmed
- Green: Susceptible
- Gray: Not applicable

Where multiple insecticide classes or types, mosquito species or time points were tested, the highest resistance status is shown.

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Data Source: World Malaria Report 2014
Map Production: Global Malaria Programme
World Health Organization

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Organophosphate resistance: 18 countries and 22% of surveyed sites

Reported organophosphate susceptibility status for malaria vectors (2010-2014)

Resistance status
- Resistance
- Possible: to be confirmed
- Susceptible
- Not applicable

Where multiple insecticide classes or types, mosquito species or time points were tested, the highest resistance status is shown.

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Data Source: World Malaria Report 2014
Map Production: Global Malaria Programme
World Health Organization

© WHO 2015. All rights reserved.
Resistance to multiple insecticide classes:
40 countries and 33% of surveyed sites

Countries reporting resistance since 2010, by number of insecticide classes (as of October 2014)

Source: World Malaria Report 2014
Preliminary trends analyses: resistance testing has increased for all four classes.
Preliminary trends analyses: resistance frequency increasing?

Number of countries

<table>
<thead>
<tr>
<th></th>
<th>Tested</th>
<th>Resistance reported for at least one site</th>
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<tbody>
<tr>
<td>Pre 2000</td>
<td>64%</td>
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<tr>
<td>2000-2004</td>
<td>58%</td>
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<tr>
<td>2005-2009</td>
<td>67%</td>
<td></td>
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<tr>
<td>2010-2014</td>
<td>74%</td>
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<tr>
<td>Pre 2000</td>
<td>63%</td>
<td>27%</td>
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<tr>
<td>2000-2004</td>
<td>70%</td>
<td>77%</td>
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<td>2005-2009</td>
<td>77%</td>
<td>75%</td>
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<tr>
<td>2010-2014</td>
<td>82%</td>
<td>63%</td>
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<tr>
<td>Pre 2000</td>
<td>69%</td>
<td>45%</td>
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<td>2000-2004</td>
<td>44%</td>
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<td>2005-2009</td>
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<tr>
<td>2010-2014</td>
<td>44%</td>
<td>74%</td>
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Pyrethroids
Organochlorines
Carbamates
Organophosphates

Global Malaria Programme
Entomological Capacity: requires enhancement

**Insectary:**
- Western Pacific: Present, Absent, Not reported.
- South East Asia: Present, Absent, Not reported.
- Europe: Absent, Not reported.
- Eastern Mediterranean: Present, Absent, Not reported.
- Americas: Not reported.
- Africa: Not reported.

**Molecular lab:**
- Western Pacific: Present, Absent, Not reported.
- South East Asia: Present, Absent, Not reported.
- Europe: Absent, Not reported.
- Eastern Mediterranean: Present, Absent, Not reported.
- Americas: Not reported.
- Africa: Not reported.

**National IR database:**
- Western Pacific: Present, Absent, Not reported.
- South East Asia: Present, Absent, Not reported.
- Europe: Absent, Not reported.
- Eastern Mediterranean: Present, Absent, Not reported.
- Americas: Not reported.
- Africa: Not reported.

**National committee of experts:**
- Western Pacific: Present, Absent, Not reported.
- South East Asia: Present, Absent, Not reported.
- Europe: Absent, Not reported.
- Eastern Mediterranean: Present, Absent, Not reported.
- Americas: Not reported.
- Africa: Not reported.
Reporting and Mapping: Challenges

- **Data quality**
  - No established comprehensive national IR monitoring plan
  - Low vector densities so tests often conducted with <100 *Anopheles*
  - Limited expertise to support data collection – especially for mechanisms
  - Incomplete or inaccurate data recording or entry
  - Inconsistencies in test procedures

- **Data management**
  - Lack of an established national insecticide resistance database
  - Limited personnel to manage available information
  - Complicated and overlapping data that are not easy to summarize
  - Sparse or incomplete data precludes identification of trends

- **Data sharing**
  - No efficient mechanism for sharing up-to-date information between partners
  - Misconception that sharing of data will limit publication opportunities
  - Late or incomplete reporting to WHO
Outlines the content and key considerations when developing and documenting national IRM plans

Includes guidance on situation analysis and implementation framework, plus annual workplans

Not intended to be rigid and prescriptive but designed to offer countries a framework while ensuring:

- adherence to GPIIRM objectives
- a degree of standardisation across countries in the structure and content of plans

- Example response tree: *Areas in which IRS is the primary intervention*
Future WHO plans for addressing insecticide resistance and entomological capacity

- Support to countries for development of national insecticide resistance monitoring and management plans
- Inclusion of additional mechanisms data in global database
- Development of insecticide resistance data management tools:
  - Online interactive platform for mapping country-level resistance data
  - Excel add-on tool to support mapping of national resistance data
- Ad hoc review of resistance monitoring procedures and related issues
- Bi-regional training on entomology/vector control including insecticide resistance
- Development of a global insecticide resistance response plan
- Advocacy for action and resource mobilization to propel implementation of GPIRM
Thank you!