RBM
Vector Control Working Group (VCWG)
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Lessons learned in Malaria Elimination in Sri Lanka

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SRI LANKA – “PEARL OF INDIAN OCEAN”
Country Profile

Total Land Area - 65,610 km²
Populations - 21,324,791
No of Provinces - 09
No of districts - 25
Capital city - Sri Jayewardenepura
Commercial city - Colombo
Vectors of Malaria in Sri Lanka

Primary (Major)
- *Anopheles culicifacies “E”*: responsible for over 80% of transmission

Secondary Vector
- *An. subpictus*

Potential Vectors
- *An. aconitus*
- *An. annularis*
- *An. barbirostris*
- *An. varuna*
- *An. vagus etc.*
Malaria Vector Breeding Sites

River margins

Down stream of dam

River bed pools

Brick pits
Malaria Vector Breeding Sites

- Irrigation canals
- Agro wells
- Tanks
- Quarry pits
History of Malaria Vector Control and Malaria Incidence – 1911-2001

- 1911: 1st Anti-Malaria Centre set up (Kurunegala)
- 1913: Incrimination of vector *Anopheles culicifacies*
- 1921: Appointment of first malarialogist
- 1934/35: A devastating malaria epidemic
- 1946: Introduction of DDT
- 1958: Malaria eradication programme launched
- 1963: Near eradication achieved
- 1969: DDT resistance in *An culicifacies* first detected
- 1975: Introduction of malathion
- 1992/93: Widespread malathion resistance in *A. culicifacies* detected
- 1994: Introduction of Lambda-cyhalothrin
- 1999: RBM Initiative launched

Epidemics:
- 1911
- 1921
- 1934/35
- 1967/68
- 1992/93

Factors contributed to the 86/87 and 92/93 epidemics

- Non-immune migratory population settled in endemic areas, poor housing
- Occupation – slash & burn cultivation, paddy cultivation, brick making, etc.
- New irrigation system created vector breeding sites
- Spread of CQ resistant *P. falciparum* strains
Introduction of “New Global Malaria Control Strategies” recommended by WHO in 1994

Strategy 1.

Early detection and prompt treatment

- Strengthen diagnostic facilities in medical institutions,
- Conduct MMC
- Chemoprophylaxis to selected groups
Introduction of “New Global Malaria Control Strategies” recommended by WHO in 1994 cont....... 

Strategy 2.

Plan and implement selective and sustainable preventive measures

- Vector control measures were targeted /selectively
- High quality/high coverage IRS in selected localities
- Area-wise rotational use of chemically unrelated insecticides for IRS to delay the development of resistance
- Large scale village trials were conducted in different districts to test the efficacy and acceptance of pyrethroid insecticides – Del, Cyf, Eto, Bif
IVM continues to be used for vector control

Introduction of larvivorous fish into breeding sites

Intermittent flushing of major canals and waterways

Space spraying during festivals
b) Insecticide treated nets (Mosquito net impregnation prog.)
Introduction of “New Global Malaria Control Strategies” recommended by WHO in 1994 cont........

Strategy 3.

To forecast and prevent epidemics
  - Entomological surveillance activities were strengthened.

Strategy 4.
  - Capacity building
  - Operational research
  - Regular assessment of malaria situation
Research projects
IWMI, UP, and Mahaweli Authority and AMC – (1994-1998)
Huruluwewa watershed
Series of studies were conducted:
• Rainfall and malaria
• Economic burden to households
• Risk factors for malaria
• Water management as a control measure
• Treatment seeking behavior
• Cost of malaria control

• An. barbirostris was incriminated as a potential vector


What was the change from 1999 onwards that leads to elimination
Roll Back Malaria Initiative launched in 1999

Six Elements in RBM

1. Early Detection
2. Rapid Treatment
3. Multiple means on prevention
4. Well Coordinated action
5. A dynamic global movement
6. Focused research
Roll Back Malaria Initiative launched -1999

- Highest Level Political commitment was secured

- National Action Group & Technical Support Group, Malaria Research Committee were established.

- Five year National Strategic Plan Developed. POA were developed for 5 pilot project districts and implemented with the support of donor agencies (WHO, IDA/WB etc.)

- Malaria control activities were targeted based on epidemiological stratification
Stratification for Vector Control

**High Risk Areas**
- API > 100
- > 30% *P.f.* infections
- CQ resistant *P.f.*
- IDP
- Development project areas
- Areas with special occupational groups
- Localities situated in river basins

**Moderate Risk Areas**
- API 50-100
- 20-30% *P.f.* infections
- Presence of significant number of breeding sites

**Low Risk Areas**
- API <50
- < 20% *P.f.* infections
- No obvious risk of sudden transmission

**Perennial /Seasonal IRS**
- ITN, Chemical larviciding

**Seasonal / Focal IRS**
- ITN, Chemical larviciding

**No IRS**
- ITN, Biological control
Sri Lanka has reduced its malaria cases by 99.9% since 1999, and aims to eliminate malaria by 2014.
Strategy used for combining IRS and LLIN

- IRS with proven efficacy was limited to highest transmission areas. Use was limited, based on distribution of disease burden and seasonality.
- LLIN were introduced in 2005. The early strategy for LLIN distribution was to target moderate transmission areas where IRS was withdrawn after blanket distribution of one net per family in selected villages.
- LLINs were also targeted for IDP families living in temporary shelters (often not suitable for IRS), conflict affected areas where regular IRS operations were not possible and areas which were difficult to access routinely.
Work towards elimination started in 2008

Goal
Sri Lanka with no indigenous malaria

Objectives of Anti Malaria Campaign 2010-2014

- To interrupt indigenous transmission of *P. falciparum* malaria by end of year 2012

- To interrupt indigenous transmission of *P. vivax* malaria by end of year 2014

- To maintain zero mortality from malaria in Sri Lanka

- To prevent reintroduction of malaria into Sri Lanka

- To obtain WHO Certification “Malaria free status”
Mass scale distribution of LLIN

<table>
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<th>Year</th>
<th>Distribution</th>
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<td>2005</td>
<td>100,000</td>
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<td>2006</td>
<td>123,000</td>
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<tr>
<td>2008</td>
<td>263,850</td>
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<td>166,600</td>
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<tr>
<td>2011</td>
<td>1,274,000</td>
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<tr>
<td>2012</td>
<td>799,250</td>
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<tr>
<td>2015</td>
<td>104,000</td>
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Pre Elimination/PoR
IRS in selected localities

Population Protected by IRS

Pre Elimination

Elimination

Year | Population
--- | ---
2006 | 812631
2007 | 994626
2008 | 728789
2009 | 559906
2010 | 290685
2011 | 167114
2012 | 75354
2013 | 51822
<table>
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<tr>
<th>Year</th>
<th>Indigenous cases</th>
<th>Imported cases</th>
<th>Deaths</th>
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<tbody>
<tr>
<td>1999</td>
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<td>2011</td>
<td>124</td>
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<td>2013</td>
<td>-</td>
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<tr>
<td>2014</td>
<td>-</td>
<td>49</td>
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<td>2015</td>
<td>-</td>
<td>36</td>
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<tr>
<td>2016</td>
<td>-</td>
<td>41</td>
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Factors contributed to the success
• **Disease Surveillance and Response**
  - Screening of individual through – APCD/ACD/MMC
  - Investigation of cases and classify as indigenous and imported
  - Maintain National malaria case register and malaria database at all levels

• **Case management and follow up**
  - New National Treatment Guideline was developed and distributed to public/private sectors
  - Introduction of ACT as 1\textsuperscript{st} line drug of choice for \textit{P. falciparum}
  - QC/QA malaria microscopy and RDT
  - Involvement of private health sector – Notification of cases to AMC,
  - Anti malarial drugs only available with the AMC
  - \textit{P.vivax} 1 year, \textit{P. falciparum} 42 days
• **Inter-sectoral collaboration**
  - Government Departments (Education, Irrigation, Agriculture, Tourism, Defense and Foreign Affaires etc)
  - NGOs (Sarvodaya)
  - International stake holders (WH), GFATM, UNHCR etc)
  - Travel agents

• **Policy Actions, Advocacy and Awareness**
  • Development of SOPs and SOWs
  • Regular updates of clinicians on malaria diagnosis and treatment
  • Chemoprophylaxis to travelers
  • Conduct public awareness programmes
Supported Documents
Entomological Surveillance

- Evidence based decision making and timely action through Entomological surveillance

### Sentinel site surveys
(Control/Elimination/PoR)
- High risk of transmission over a period of time
- Increase potential risk for vector breeding

### Spot checks
(Control/Elimination/PoR)
- Not covered by SSM
- High receptive areas
- High vulnerable areas

### Case based surveys
(Elimination/PoR)
- Imported case
Vector Surveillance in sentinel sites

- Prevalence and seasonal fluctuation of density (CBHC, CBT, LS)
- Biting behavior (HLC)
- Resting behavior (Indoor/outdoor HC, PSC, WTC)
- Breeding behavior and density (LS)
- Susceptibility to insecticides
- Impact of vector control interventions
Adult density of *Anopheles culicifacies* in year 2012 (Data from CBHC)
Adult density of *Anopheles culicifacies* in year 2014 (Data from CBHC)
Larval density of *Anopheles culicifacies* 2012 and 2014
Apply appropriate vector control interventions based on the Vector Bionomics

IRS, Chemical Larviciding, LLIN, Space spraying
Research for Timely Response

Objective

To determine the susceptibility levels of malaria vector mosquitoes to currently available pyrethroids in order to select the most suitable insecticides for malaria vector control in the Elimination Phase in Sri Lanka.

Methodology

Contact bioassays using WHO standard test kits and procedure. 

An. culicifacies and An. subpictus mosquitoes (n=100) were tested against discriminative dosage(s) of
- Bifenthrin (2%)
- Cyfluthrin (0.15%)
- Deltamethrin (0.025% and 0.05%)
- Etofenprox (0.1% and 0.5%)
- Lambdacyhalothrin (0.1% and 0.05%)
- Permethrin (0.25% and 0.75%)

Involvement of monooxygenase metabolic enzymes in pyrethroid resistance was indirectly tested by exposing mosquitoes to 4% piperonyl butoxide (PB) impregnated paper for one hour prior to bioassay experiments.
Batticaloa

- An. culicifacies
- An. subpictus

Percentage Mortality

New Dosages

2% Bifenthrin 0.15% Cyfluthrin 0.05% Deltamethrin 0.05% λ-cyhalothrin 0.5% Etofenprox 0.75% Permethrin 0.025% Deltamethrin 0.1% λ-cyhalothrin 0.1% Etofenprox 0.25% Permethrin

Former dosages
Kurunegala

- **An. culicifacies**
- **An. subpictus**

**Percentage Mortality**

- **New Dosages**
  - 2% Bifenthrin
  - 0.15% Cyfluthrin
  - 0.05% Deltamethrin
  - 0.05% λ-cyhalothrin
  - 0.5% Etofenprox
  - 0.75% Permethrin
  - 0.025% Deltamethrin
  - 0.1% λ-cyhalothrin
  - 0.1% Etofenprox
  - 0.25% Permethrin

- **Former dosages**
CONCLUSIONS

- *An. culicifacies* and *An. subpictus* populations have developed resistance to pyrethroids

- Monooxygenase enzyme based mechanism confer pyrethroid resistance in both vectors.

RECOMMENDATIONS

- Species specific discriminating dosages for local vectors should be specified.

- If pyrethroid is continuing for IRS and LLIN, new insecticide products with synergists should be introduced in malaria vector control programmes.
Shrinking Malaria Map in Sri Lanka

Malaria Cases
- 0
- 1 - 250
- 251 - 500
- 501 - 750
- 751 - 1000
- >1000

- 1999
- 2001
- 2003
- 2005
- 2008
- 2012
- 2013
- 2014
- 2015
- 2016
"I have the honour to inform you that the Sri Lanka has achieved malaria elimination. This is based on the assessments of the malaria situation in the country by the WHO evaluation teams in Nov 2015 & May 2016, the final assessment by an independent evaluation team on 26 July - 11 Aug 2016, and the review by external experts that included the Chair & two members of the Malaria Policy Advisory Committee, two independent malaria experts, the Director of Global Malaria Program & three other technical experts on malaria within WHO". 

- 19 Sep 2016
WHO CERTIFIES
SRI LANKA
MALARIA-FREE

SEAR becomes
2nd WHO Region
to achieve
malaria and
neonatal tetanus
elimination.

Sri Lanka
eliminates
lymphatic
filariasis.