MANAGING DISEASE VECTORS: LESSONS LEARNED-LESSONS IGNORED

Global Health Histories Seminar

Axel Kroeger

Annual DHF cases
(A) INTRODUCTION
Insect vectors and "their diseases"

• WHO are they
• WHERE do they occur
• HOW do we know?
• WHAT are the control options?
Examples of insect vector borne diseases

DENGUE

MALARIA

Visceral Leishmaniasis

Others…

Chagas

Lymphatic Filariasis
Examples of insect vectors

- **Triatomine**: Chagas
- **Aedes aegypti**: Dengue
- **Anopheles**: Malaria
- **Sand fly**: Leishmaniasis
WHERE? The vector belt around the world (example dengue)
HOW DO WE KNOW?

Pioneers and victims
Patrick Manson  
*Lymph. Filariasis*  
1878

Ronald Ross  
*Malaria*  
1897

Carlos Chagas  
*Chagas Disease*  
2009

**PIONEERS IN VECTOR BORNE DISEASE RESEARCH**
VICTIMS OF VECTOR BORNE DISEASE RESEARCH

Clara Maass

Clara was buried in Havana, Cuba and later reburied in New Jersey at Fairmount Cemetery.
Vector Control: What are the options?

• In the early days

• Today
Larviciding & biological control in the old days

- Screening of houses
- Mosquito nets
- Drainage & filling of swamps
- Oil or Paris Green in breeding sites

Early 1940`s
Current control options

**Biological**
- Personal protection
- Containers:
  - Larvivorous fish
  - Copepods (mesocyclops)
  - Dragon flies
- Clean-up campaigns (dengue)
- Lime plastering (sand flies)
Other ecosystem management

**Chemical**
- IRS (Indoor Residual Spraying)
- ITNs (Insecticide treated nets)
- Anti-larval: Pyroproxifen, Temephos, Bti
- Insecticidal lid covers
- Fogging

**Others**
- Genetically modified vectors
(B) THE IRS STORY & HISTORY

- Aim
- Effort
- Cost
- Achievements
- The managerial & political face

IRS= Indoor Residual Spraying
AIM: Reduction of vector density/longevity through IRS that no further transmission occurs ("Break point"; Threshold level)
THE EFFORT: Pyrethroid spraying with Hudson pump
THE EFFORT
DDT spraying in India with Stirrup Pump
IRS: The managerial & political face (1)

"Classical" IRS programmes:

- Practiced at a massive scale during and after WWII
- Enabled by DDT
- Strengthened by the Malaria Eradication programme
- Organized as independent vertical programme
- Planned usually in an "eradication mood" for a limited time period due to its high costs
- Not applied in high endemic areas of Sub Saharan Africa
DEPARTMENT OF STATE

To all to whom these presents shall come.

Greeting:

I, the undersigned Secretary of State of the United States of America, hereby request all whom it may concern to permit

Fred L. Soper,

a citizen of the United States, safely and freely to pass and in case of need to give all lawful aid and protection.

This passport is valid for use only in the following countries and for periods specified unless amended.

The bearer is accompanied by his wife, Juliet S.

Given under my hand and the seal of the Department of State at the City of Washington the 31st day of January of the year 1919, and of the Independence of the United States the one hundred and forty fourth.

[Signature]

Robert Lansing.

PERSONAL DESCRIPTION

Age 24 years, Height 5' 8" and a half, Eye Color "C"

Habitation, "E".


Occupation: Physician.

Photograph of Beamer.

I hereby certify that the attached photograph bears the signature of the person in whose name this passport is issued, and that the seal of the Department is impressed upon the photograph,

Fred L. Soper, M.D.,

Signature of Beamer.

No. 153995.
Fred Soper`s obsession with IRS (1)

After having achieved the eradication of A. gambiae from Brazil, Soper was one of the first to use the new weapon against malaria, called DDT, at a large scale.

His principles:
- apply motivation, discipline, organization

His approach:
- uniforms for malaria inspectors
- rigorous protocol for inspecting houses
- mapping, number houses and sectors, assign inspectors to each sector
- bonus for supervisors who found larvae that the inspector had missed, fee reduction for inspectors who deviated by > 10 minutes from their spraying schedule
ACHIEVEMENTS OF IRS:
• "ELIMINATION" OF DENGUE VECTORS FROM THE AMERICAS...AND RE-INFESTATION (map)
• ELIMINATION OF CHAGAS VECTOR FROM CONO SUR" ... AND PARTIAL RE-INFESTATION
• ELIMINATION OF MALARIA FROM SUB-TROPICAL AREAS
• OTHERS...
Fred Soper`s obsession with IRS (2)

However, even in the heydays of Malaria Eradication, serious problems arose:

• Insecticide resistance
• Environmental disequilibrium: bedbugs and caterpillars in Malaysia
• "Silent spring" by Rachel Carlson (1962)
• Corruption with insecticides (diluted sprays)
• Massive re-infestation in previously "free" areas
• People`s "resistance" to IRS (particularly the better-off)
"Modified" IRS programmes in the 1990`s (LA, Asia) because of:

- **Decline in programme efficiency** due to
  - Loss of national & international funding
  - More expensive new insecticides
  - Establishment of powerful malaria Unions
  - Loss of managerial skills and flexibility

- **Decentralized health sector** with threats and opportunities:
  - Integration into general health services
  - Massive reduction of workforce (spray teams often hired instead of being employed)
  - Loss of authority
  - Lack of programme expertise at district/sub-district level
"Modified" IRS programmes in the 1990`s (LA, Asia) because of:

- Decline in public attention due to
  - Decrease in malaria mortality
  - Urbanization of large population groups
- New challenges for vector control services
  - Advent of other neglected diseases such as dengue, LF, Leishmaniasis
- Advent of new tools, particularly ITNs
  - Emphasis shift towards ITNs in Africa
It took 10 years to get research findings on ITNs into national programmes in Africa supported by massive international funding.

Mainly "vertical" distribution pattern as during the "classical" IRS period.

Will the IRS story be repeated when international donors disappear?
1st lessons on IRS & vector control

- One intervention (IRS) is not sufficient to "eradicate" malaria or any other vector borne disease (lesson learned?)
- The weakness of managerial and political systems as well as "human nature" have to be taken into account (lesson learned?)
- Massive investment does not guarantee sustainable success in terms of reducing vector densities to threshold levels if the performance at all levels is not ensured (lesson learned?)
IRS today

- Complexity of IRS programmes
- Efforts needed
- Major threats: performance problems
- Political and other interferences
## COMPLEXITY: Procurement of insecticides and funds release (National Level, India)

<table>
<thead>
<tr>
<th>Activity</th>
<th>First Year</th>
<th>Second Year</th>
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<tbody>
<tr>
<td></td>
<td>Jan  F  M  A  M  J  Jun  Jul  Aug  Sep  Oct  Nov  Dec</td>
<td>Jan  F  M  A  M  J  Jun  Jul  Aug  Sep  Oct  Nov  Dec</td>
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<tr>
<td>National level</td>
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<tr>
<td>PROCUREMENT OF INSECTICIDES</td>
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<tr>
<td>Project Insecticide requirements</td>
<td></td>
<td></td>
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<tr>
<td>Budget allocations</td>
<td></td>
<td></td>
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<tr>
<td>Approval of MOH</td>
<td></td>
<td></td>
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<tr>
<td>Placing order to HIL</td>
<td></td>
<td></td>
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<tr>
<td>Start of supply</td>
<td></td>
<td></td>
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<tr>
<td>Completion of supply to state</td>
<td></td>
<td></td>
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<tr>
<td>Distribution to districts and PHCs</td>
<td></td>
<td></td>
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<tr>
<td>Spray 1st Cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spray 2nd Cycle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RELEASE OF FUNDS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project requirements</td>
<td></td>
<td></td>
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<tr>
<td>Examination through PIP</td>
<td></td>
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<tr>
<td>Approval of BE</td>
<td></td>
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<tr>
<td>Release of 1st</td>
<td></td>
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### 14 months with 7 steps
THE EFFORT: Annual costs of IRS

INDIA:
• 20.4 Million Dollar for IRS (80% of this for insecticide)
DDT per household = 1.6$

Dengue vector control, example:
• Malaysia 240.000$ per 1 Mio. Population
• Thailand 188.000$ per 1 Mio population
• Singapore 2.400.000$ per 1 Mio. Population
RESULTS

Filter paper method to determine insecticide concentration achieved on the wall

INSECTICIDE CONCENTRATION ON THE WALL AS % OF THE EXPECTED VALUE

- **DDT** (Country A)
- **Pyrethroid** (Country B)

- **80%**
- **7%**

Comment: Very high variation within and between HHs
IRS PERFORMANCE

Regular spray

Irregular spray

Spraying over food

Spraying objects
PERSONAL PROTECTION

IRS PERFORMANCE

HAT/FACE SHIELD

MASK

GLOVES

LONG SLEEVED OVERALLS

BOOTS

RESULTS

...more comfortable, but more dangerous
# Observation of IRS at community level

<table>
<thead>
<tr>
<th>Items</th>
<th>Observation</th>
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</thead>
<tbody>
<tr>
<td><strong>Country A</strong></td>
<td><strong>Country B</strong></td>
</tr>
<tr>
<td>General condition of the pump:</td>
<td></td>
</tr>
<tr>
<td>i. Leakage</td>
<td>No leakage</td>
</tr>
<tr>
<td>ii. Nozzle</td>
<td>Good</td>
</tr>
<tr>
<td>iii. Pressure gauze</td>
<td>Good</td>
</tr>
<tr>
<td>Method of mixing insecticide</td>
<td>Improper</td>
</tr>
<tr>
<td>Shaking of the pump</td>
<td>Not enough</td>
</tr>
<tr>
<td>Distance of nozzle from the surface (45cm from the surface)</td>
<td>Not maintained</td>
</tr>
<tr>
<td>Spray swath</td>
<td>Not uniform</td>
</tr>
<tr>
<td>Marking of sprayed house</td>
<td>Incomplete</td>
</tr>
<tr>
<td>Use of safety procedures (gloves, coat, eye glasses, boots, caps, masks etc.)</td>
<td>No</td>
</tr>
</tbody>
</table>
POLITICAL & MANAGERIAL & CLIMATIC INTERFERENCE IN IRS

Sorry…

• …we could not start because of the elections
• … we could not start because of late approval of budget
• …we could not finish because the monsoon came early
• …we could not complete because we ran out of insecticide
• …we could not continue because of industrial action
• …we could not train sprayers because of the large number

Etc…..
Lessons learned for IRS

• Staff training and performance monitoring are crucial for the success *(lessons from Fred Soper)*
• Political and managerial bottle necks are a "natural" part of IRS programmes and have to be dealt with *(not accepted by Fred Soper)*
• Combination with other vector control methods are unavoidable *(not yet understood by Fred Soper)*
(C) LESSONS OF WHAT IS NEEDED

• IVM strategy
• "Intelligent" control services
• Comprehensive view of vector ecology
• Environmental Management (EVM)
• Involvement of communities and other partners
INTEGRATED VECTOR MANAGEMENT

- Intra and Intersectoral collaboration
- Evidence based planning and decision making
- Strengthened communication between partners
- Multi-disease and vector control
- Integrated use of methods (ITNs etc)
- Integration with other disease control measures
Intelligent vector control services are needed which are able:

- To see the whole picture,
- To do routine interventions along with special interventions
- To react quickly to un-usual events
- To involve communities and other partners

**Routine Vector Control** (mechanical, biological, chemical)

**Responsive Vector Control** (epidemic response)

**Social Mobilization**

**Disease Surveillance** (collected/processed by clinical/epidemiol. services)

**Vector Surveillance**

**Overall Approach**

- "Catch up" kill of adults
- "Catch up"/"keep up" elimination of breeding
- "Catch up"/"keep up" elimination of breeding

**Targeting Adult Vectors**

**Targeting Product Cont.**

**Targeting Index Cases**

**Targeting Traps**

**Passive**

**Active**

- Close link to HIS&Epidemiology
- Endemic channel & mapping skills (GIS/GPS if available)
- Application of indicators to trigger alarm
- Sample size determination (sufficient traps/staff)

- Larval surveys (simple collection tools)
- Pupal-demographic survey methodology
- Bioassays (WHO cones & cylinders/test paper)
- Mngt. of staff/resources/M&E

- As above
- ITM campaigns/maintenance

- Indoor UVL (skilled staff/UVL)
- See Soc. Mobiliz. Institution partnering

- Communication/social marketing skills; leadership, partnering (/negotiation skills)

- As above
Intelligent vector control services are to be supported by Information Technology wherever the resources are available.
Understanding & responding to the complexity of vector dynamics: The dengue example
Understanding vector ecology: Landscape mapping and eco-tope characterisation
SELECTIVE VECTOR CONTROL targeting productive containers
Mechanical control of dengue vectors: labour intensive; potential for community involvement

Environmental management:
Cotton Net Sweeper in Myanmar
Environmental management of VL Vectors (sand flies): lime plastering
Understanding attitudes towards vector management

- What are peoples` perceptions of the problem?
- What would they be willing and able to contribute?
- Who else should be involved?

Focus group discussion with female members:
COMMUNITY INVOLVEMENT

- Cooperative for malaria control
- Putting containers upside down (dengue)
- Support of Control staff
- Environmental management
Example Bangladesh:
- Management: Central community dipping point
- Dipping carried out by community volunteers and HH members
- 98% Coverage achieved
Summary of forgotten lessons

• Combine control tools & develop sustainable strategies
• Amalgamate Fred Soper`s discipline with a flexible community directed approach
• Recognize potentials and limitations of community involvement
• Realize the programmatic difference between "attack phase" and "maintenance phase"
• Accept programme failures as lessons which have to be learned
Working together- achieving together