How malaria became a vector borne disease

Randall M. Packard, PhD
Institute of the History of Medicine
Johns Hopkins University
Malaria is a Mosquito Problem

Charles Laveran

Ronald Ross

Giovanni Grassi
Malaria 101
Vector Control Methods

- Drainage
- Larvicide (oil, Paris Green)
- Spraying for adult mosquitoes
- Screening
Early Successes of Vector Control

- Watson in Malaya
- Swellengrebel in Indonesia: “species sanitation”
- Gorgas in Panama
- Rockefeller Foundation in the Americas
Limits of Vector Control

- Costs limited coverage
- Required entomological research
- A. quadrimalaculatis vs. A. maculipennis
Malaria is a Medical Problem

- Robert Koch: “Treat the patient, not the mosquito.”
- Less expensive
- Problem of “anophelism without malaria”
Malaria is a Social Disease

“Malaria flees before the plow”

- Bonification
- Malaria resulted from exploitation of workers
- Higher wages, improved working conditions, housing and diet were the first step in combating malaria.

Angelo Celli
“...the diminution of local malaria in England was due neither to natural causes nor to the intentional application of any particular preventive method reputed to be specific, but to progressive improvements of a social economic, educational, medical, and public health character.” S.P. James, 1929
Figure 4. Geographical Distribution of malaria in England in the 1860s
The Disappearance of Malaria

- Drainage and expansion of farm land
- Increases in cattle herding
- Improved housing
- “Growing out of malaria”
Malaria moves west.
Malaria and Development

“It would seem that with even a moderate betterment of social conditions, malaria in the U.S. tends to disappear...nearly every phase of economic improvement has had some effect on the reduction of malaria.” (M. A. Barber, 1926)
“The Commission feels bound to reiterate the importance of the general social and hygienic condition of a people... Better housing, and ampler more varied dietary, and better environmental conditions make for more intelligent and willing people and for greater individual resistance...”
Bonification, Rural Reconstruction and Malaria
Malaria Control & Rural Uplift

- Palestine, 1920s
- TVA, 1930s
- LNHO, Rural Rehabilitation Program in the Kaingsi Province of China
- IHD, Rural Health and Development Program in North China in 1935
Summary of Pre-War Approaches

- Diverse strategies
- Often used in combination
  - Pontine marshes
- Importance of social forces
Hegemony of Vector Control

- Fred Soper’s species eradication successes in Brazil
- Hackett and Missiroli explain “anopheles without malaria”
- World War II and the narrowing of entomological research
“DDT has made earlier methods of malaria control superfluous” – Rockefeller IHD, 1947
Lessons of History

“That physicians, malarialogists, and sanitarians integrate their activities with those of agriculturalists, demographers, social scientists, economists, educators, political and religious leaders is of the utmost importance.” - Paul Russell, *Man’s Mastery over Malaria*, 1955
Empire Strikes Back

- Changing political environment
  - Failed efforts to expand rural hygiene experiments in Latin America 1938 (Hugh Cummings)
- Purge of LNHO Leadership
- Coldwar politics and Postwar division of labor
ERADICATE MALARIA
BY SPRAYING

MALARIA ERADICATION PROGRAMME INDIA
THE NATIONAL MALARIA CONTROL PROGRAMME HAS NOW BECOME AN ERADICATION PROGRAMME CO-OPERATE ERADICATE MALARIA.
What went wrong

- Over reliance on a single approach
- Lack of research and development into alternatives
- Failure to address weaknesses in health infrastructure
- Failure to recognize the importance of social determinants of malaria
From Eradication to Control

- Return to multiple strategies
- Integration with basic health services
- Emphasis on case treatment, community participation, and integrated vector management
El Salvador’s Integrated Malaria Program

- Epidemiological Mapping
- Entomological Surveillance
- Environmental Control
- Volunteer Collaborator Program
- Presumptive Treatment
- Rapid testing
Cases by Year El Salvador

Number of cases

Year

1980 81 82 83 84 85 86 87 88 89 1990 91 92

100,000 95,835 80,000 60,000 40,000 10,000 0

4539
Malaria Incidence in El Salvador Compared with Cotton Production (1980-1990)

Najera, et.al., 1998
Decline of Residual Spraying

- Garki Project, Nigeria, 1970-1976
- 1979 Expert Committee Report
- WHA resolution 38.24 (1985)
- RBM early resistance to use of IRS
Reasons for decline in IRS

- Effects of Failed Eradication Campaign
- Lost generation of malariaologists and entomologists
- PHC movement
- Environmental lobby
- Neoliberalism and World Bank
Declining Support

- Multilateral funding declined from $13.7 million in 1969 to $7.8 million in 1974
- WHO's malaria advisory staff decreased from 444 to 155 between 1967 and 1977
- UNICEF's staff dropped from 115 to 37 between 1967 and 1977
- National programs cutback
Malaria Cases in India

US Foreign Aid as a Per Cent of India's Total Aid

Percent of Foreign Aid


0% 10% 20% 30% 40% 50% 60% 70% 80%


Malaria Cases in India


0 100000 200000 300000 400000 500000 600000 700000
SEARO, WHO, Malaria Situation in SEARO Countries, 2003
RBM Interventions 1998-2006
“Malaria control is not the isolated concern of the health worker. It requires partnership of community members and the involvement of those involved in education, the environment in general, and water supply, sanitation and community development in particular. Malaria control must be an integral part of national health development and health concerns must be an integral part of national development programmes.”

– Global Strategy for Malaria, 1992
### Table II.4: Summary of annual global costs

<table>
<thead>
<tr>
<th>Cost (US$ millions)</th>
<th>2009</th>
<th>2010</th>
<th>2015</th>
<th>2020</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>LLIIs/ITNs</td>
<td>2,091</td>
<td>2,091</td>
<td>1,689</td>
<td>1,807</td>
<td>1,035</td>
</tr>
<tr>
<td>IRS</td>
<td>1,632</td>
<td>1,883</td>
<td>2,026</td>
<td>2,047</td>
<td>1,531</td>
</tr>
<tr>
<td>IPTp</td>
<td>6</td>
<td>8</td>
<td>9</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>Prevention cost</td>
<td>3,728</td>
<td>3,982</td>
<td>3,724</td>
<td>3,864</td>
<td>2,576</td>
</tr>
<tr>
<td>RDTs</td>
<td>679</td>
<td>975</td>
<td>368</td>
<td>109</td>
<td>43</td>
</tr>
<tr>
<td>ACTs</td>
<td>257</td>
<td>356</td>
<td>164</td>
<td>107</td>
<td>41</td>
</tr>
<tr>
<td>Chloroquine and primaquine</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Severe case management</td>
<td>27</td>
<td>23</td>
<td>16</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Case management cost</td>
<td>968</td>
<td>1,359</td>
<td>550</td>
<td>226</td>
<td>87</td>
</tr>
<tr>
<td>Community health workers</td>
<td>79</td>
<td>82</td>
<td>97</td>
<td>96</td>
<td>75</td>
</tr>
<tr>
<td>Training</td>
<td>104</td>
<td>96</td>
<td>91</td>
<td>93</td>
<td>58</td>
</tr>
<tr>
<td>M&amp;E and OR</td>
<td>207</td>
<td>242</td>
<td>245</td>
<td>251</td>
<td>298</td>
</tr>
<tr>
<td>Infrastructure / inst. strengthening</td>
<td>248</td>
<td>419</td>
<td>331</td>
<td>347</td>
<td>283</td>
</tr>
<tr>
<td>Program cost</td>
<td>638</td>
<td>839</td>
<td>764</td>
<td>787</td>
<td>714</td>
</tr>
<tr>
<td>Global control and elimination cost</td>
<td>5,335</td>
<td>6,180</td>
<td>5,037</td>
<td>4,877</td>
<td>3,378</td>
</tr>
<tr>
<td>Information needs</td>
<td>126</td>
<td>126</td>
<td>133</td>
<td>113</td>
<td>77</td>
</tr>
<tr>
<td>Diagnostics</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Drugs</td>
<td>322</td>
<td>322</td>
<td>322</td>
<td>154</td>
<td>154</td>
</tr>
<tr>
<td>Vector control interventions</td>
<td>108</td>
<td>108</td>
<td>108</td>
<td>105</td>
<td>65</td>
</tr>
<tr>
<td>Vaccines</td>
<td>190</td>
<td>190</td>
<td>224</td>
<td>296</td>
<td>152</td>
</tr>
<tr>
<td>Research &amp; Development cost</td>
<td>759</td>
<td>759</td>
<td>800</td>
<td>681</td>
<td>460</td>
</tr>
<tr>
<td>Total cost</td>
<td>6,094</td>
<td>6,939</td>
<td>5,837</td>
<td>5,559</td>
<td>3,838</td>
</tr>
</tbody>
</table>

- Global Malaria Action Plan, 153
Projected Expenses 2009

- Vector Control = 99% (Nets 54%, IRS 46%) of preventive budget and 61% of total
- Intermittent therapy > 1%
- Case Management = 15%
- R&D = 12.5%
- Infrastructure strengthening = 4%
Ignoring the social determinants of malaria

- Civil unrest and violence
- Refugees
- Poverty
- Deteriorating health services
...weaknesses in socioeconomic development, such as poverty, poor quality of housing and limited access to healthcare limit the feasibility and effectiveness of malaria control strategies. At the national level, there are often only limited financial resources for malaria-control intervention which, compounded with the human resource crisis in the public health sector, have led to fragmented implementation of control strategies that were limited in scale and in the populations targeted.” (GMAP, 121)
War, Refugees, and Malaria
- Weakens health systems
- Disrupts malaria control
- Transforms environment
- Displaces people
Malaria & Civil War in DRC

- Health centers destroyed (70% reduction)
- Malaria control programs disrupted
  - 2003/4 24,000 of 500,000 ITNs
- Forest cover destroyed
- Malaria causes 45% of all childhood death (WHO)
Refugees and Malaria

- Displaced populations more difficult to protect
- Displaced populations exposed to malaria (e.g. Southern Sudan)
- Refugees may introduce malaria into low risk areas (e.g. Burundi, 1990s)
- Camps produce malaria
- Malaria is the leading cause of death among refugees (UNHCR)
- In 2007, malaria caused 21% of all reported refugee deaths and 26% of <5 yrs refugee deaths
- Malaria caused 23% of total morbidity and 25% of under five morbidity.
- 13% of all cases reported by WHO linked to forced migration/civil war
Malaria and Poverty

**GNP per capita**

**Malaria Index**

Sachs and Gallup, 2001
“It is certainly true that poverty itself can be held accountable for some of the intense malaria transmission recorded in the poorest countries…” (Sachs and Malaney, 2002)
Poverty in Africa

Economic growth in Africa is expected to be only 2.8 per cent in 2009, less than half of the 5.7 per cent estimated for 2008. (AEO, 2009)
GDP per capita in developing countries

Source: World Bank 2004
Malaria and Poverty

- Individual poverty
  - Limits ability to take preventive measures
  - Limits ability to treat sick
  - Places people at risk

Photograph by John Stanmeyer
Socioeconomic Status and Household Spending on Malaria Prevention, Sudan 2006

![Graph showing household spending on malaria prevention by socioeconomic status]

- Quartile 1: Low spending on all tools and ITNs.
- Quartile 2: Moderate spending on all tools and ITNs.
- Quartile 3: High spending on all tools and ITNs.
- Quartile 4: Very high spending on all tools and ITNs.
“Makorokoza” in Zimbabwe

- 1990s economic downturn
- 100,000-500,000
- Malaria
  - 25/1000 in 1992
  - 150/1000 in 2002
Malaria and Poverty

- National Poverty
  - Undermines preventative services
  - Undermines ability to provide healthcare
Impact on Health System: Zambia

- Per capita GDP
  - 1970 = $1600
  - 2003 = $900

- Per capita health expenditure
  - 1970 = US$23
  - 2005 = US$ 11

- Half of clinics closed by 2005
Figure 21. Malaria Incidence and Mortality, Zambia

Impact on Health Services

“Africa’s health systems are too weak and services are too under-resourced to support a targeted reduction in the disease burden.” (Dr. Margaret Chan, September 2008)
Vector Control and Future of Malaria

- Have we put too much faith in power of insecticides to eliminate malaria?
- Can we eliminate malaria without investment in health infrastructure?
- Can we eliminate malaria without addressing problems of poverty, violence and displaced populations?
Lesson from History

“The proper policy is not the protection policy, nor the mosquito reduction policy, nor the quinine policy, but an opportunistic policy that uses any weapon it can.”

Ronald Ross, *The Prevention of Malaria*, 1911
“…public-health programme[s] cannot be planned in a vacuum, but only as a vital part of a broad programme of social improvement…It is not enough then, for the health administrator to develop the soundest possible programme for his own field of social endeavor…He must also sit down with experts on agriculture, on industry, on economics, and on education and integrate his specific health programmes as part of a larger programme on social development.” C. E-A. Winslow The Cost of Sickness, the Price of Health, 1951