Integrated Control of Tropical Diseases

Progress in Control and Elimination of Lymphatic Filariasis
## The Targeted NTDs

<table>
<thead>
<tr>
<th>LF</th>
<th>Oncho</th>
<th>Schisto</th>
<th>STH</th>
<th>Trachoma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mosquitoes</td>
<td>Black flies</td>
<td>Snails</td>
<td>Direct fecal contamination</td>
<td>House Fly</td>
</tr>
</tbody>
</table>
Lymphatic Filariasis (LF): a profile

- Affects 120 million people
  - 40 million: overt disease
  - 80 million: hidden damage, microfilaremia
    - acquired in childhood
- 1.3 billion people ‘at risk’
- 83 endemic countries
- Parasites: *W. bancrofti*-90%
  - *B. malayi*-10%
- Mosquito vectors
- Leading cause of disability, economic loss, stigma
Adult worms cause the disease

*W. bancrofti* in scrotal lymphatic

Dreyer & Noroeas
Microfilariae: responsible for transmission

Asymptomatic microfilaremia
Effective tools: for intervention

The anti-filarial drugs

- Diethylcarbamazine (DEC)
- Ivermectin (IVR)
- Albendazole (ALB)
Blood Microfilaria Levels (W. bancrofti)

Single-Dose Treatment

Ismail et al. ‘96
## Broad anti-parasite effectiveness of Albendazole & Ivermectin

<table>
<thead>
<tr>
<th>Parasite / Infection</th>
<th>Albendazole (400mg)</th>
<th>Ivermectin (200 mcg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hookworm</td>
<td>95%</td>
<td>0-20%</td>
</tr>
<tr>
<td>Roundworm</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Whipworm</td>
<td>40-60%</td>
<td>10-50%</td>
</tr>
<tr>
<td>Strongyloides</td>
<td>45%</td>
<td>95%</td>
</tr>
<tr>
<td>Cutaneous larva migrans</td>
<td>80%</td>
<td>100%</td>
</tr>
<tr>
<td>River blindness</td>
<td>-</td>
<td>95%</td>
</tr>
<tr>
<td>Lice</td>
<td>-</td>
<td>100%</td>
</tr>
<tr>
<td>Scabies</td>
<td>-</td>
<td>100%</td>
</tr>
</tbody>
</table>
The strategy to interrupt transmission and eliminate LF

The GPELF

- Identify all LF-endemic areas
- Treat *entire* ‘at risk’ *populations*
  - 2-drug, single-dose regimens once-yearly x 4-6 years
  - by ‘mass drug administration’ (MDA)
LF Elimination:  
-early donations of resources-

To donate all albendazole required for LF elimination; to support selected research and program activities

To expand Mectizan Donation Program to provide ivermectin for LF treatment where onchocerciasis co-exists
LF Elimination: 
-early donations of resources-

To donate all albendazole required for LF elimination; to support selected research and program activities

To expand Mectizan Donation Program to provide ivermectin for LF treatment where onchocerciasis co-exists

Long-term support of programme development and intervention in the countries and globally, through WHO and the LF support centres

To support activities toward elimination of LF from all Arab Fund member countries

To support programme training activities and efforts to eliminate LF from the Pacific island nations (PacELF)
Global Alliance
To Eliminate Lymphatic Filariasis

WHO
Arab Fund for Economic and Social Development
Liverpool School of Tropical Medicine
CDC US Centers for Disease Control and Prevention
GlaxoSmithKline
USAID
Merck
DFID Department for International Development
RTI International
Bill and Melinda Gates Foundation
World Bank
IMA
Ministry of Health and Welfare Japan
The Task Force for Global Health
The Carter Center
Global Programme to Eliminate LF

*made*

- **conceivable** by scientific advances (’80s - ‘90s)
- **feasible** by WHA resolution (1997)
- **possible** by drug donations (1998)
- **real** by dedicated implementers and facilitators (MOH, WHO, BMGF, development agencies)
- [a **likely success** by increased support through NTD programs – USAID, DFID, Japan, others]
What has been achieved?

The first 10 years of the GPELF
(2000 – 2009)
## GPELF: Endemic country progress

<table>
<thead>
<tr>
<th></th>
<th>Countries</th>
<th>Population</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target</strong></td>
<td>83</td>
<td>1,331,000,000</td>
<td>2020</td>
</tr>
<tr>
<td><strong>Milestones</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mapping complete</td>
<td>60</td>
<td>1,103,947,000</td>
<td>2010</td>
</tr>
<tr>
<td>started</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>needed</td>
<td>11</td>
<td></td>
<td></td>
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<tr>
<td>MDA started</td>
<td>55</td>
<td>1,212,226,537</td>
<td>2010</td>
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<tr>
<td>needed</td>
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<td></td>
</tr>
<tr>
<td>finished</td>
<td>5 (+10)</td>
<td>10,691,970</td>
<td>2010</td>
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<tr>
<td>Surveillance</td>
<td>12</td>
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</table>
### Cumulative GPELF Treatments

<table>
<thead>
<tr>
<th>Drug(s)</th>
<th>Treatments Delivered</th>
<th>Individuals Treated</th>
</tr>
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<tbody>
<tr>
<td>IVM+ALB</td>
<td>255,737,000</td>
<td>54,100,000</td>
</tr>
<tr>
<td>DEC+ALB</td>
<td>951,472,000</td>
<td>213,407,000</td>
</tr>
<tr>
<td>DEC Alone</td>
<td>1,623,856,000</td>
<td>378,047,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2,831,065,000</strong></td>
<td><strong>645,554,000</strong></td>
</tr>
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</table>

### Graphical Representation

- The graph shows the cumulative number of treatments delivered from 2000 to 2009.
- The treatments delivered increase significantly over the years, reaching a total of 2,831,065,000 treatments by 2009.
- The number of individuals treated also increases, reaching 645,554,000 by 2009.

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*Note: The graph and table data are based on the given text and do not include any extrapolation or assumptions.*
Cumulative Tablets donated (IVM & ALB) 2000-2008
Albendazole Donation

1.6 billion treatments/tablets
246 full-size containers (each 40 feet long) = 9840 feet end-to-end (1.9 miles)
Each tablet  - weighs 1 gm  >> 1,600 metric tons
    - length 19 mm  >> 18,890 miles end-to-end
By end of 2010 GSK will donate 600 million treatments/yr (mfg, pkg, ship)
What effect have these MDAs had on microfilaremia?

2000 – 2007
Effect of MDA on mf prevalence

After MDA round

MF prevalence (% pre-treatment)
## GPELF: Endemic country progress

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Progress by Regions

Total population under MDA by 2008

- SEAR: 86.2%
- AFR: 9.5%
- PAC: 3.3%
- EMR: 0.3%
- AMR: 0.7%

At-risk population yet to be treated

- AFR: 75%
- PAC: 2%
- AMR: 1%
- EMR: 2%
- SEAR: 20%
Impact of the Global Programme to Eliminate LF

2000 – 2008
Health Impact of GPELF

Two distinct sources:

1) LF-related benefits
   - those directly from the Programme activities in preventing acquisition of LF disease or arresting its progression

2) ‘Beyond-LF’ benefits
   - those derived principally from the broad-spectrum drugs, albendazole and ivermectin, used in the Programme
Assessing the LF-related health impact

- **Impact #1:** Protecting newborns from acquiring infection (and disease)
- **Impact #2:** Protecting those already infected from progressing –
  - asymptomatic to overt disease
  - worsening of existing LF disease
## Health/Economic Impact of the GPELF

- **first 8 years** -

<table>
<thead>
<tr>
<th>Health Impact</th>
<th>Individuals Protected</th>
<th>Disease Prevented</th>
<th>DALYs Averted</th>
<th>Economic Cost Prevented</th>
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<td>Prevention of infection in newborns</td>
<td>6.6 million babies</td>
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<td>9.5 million people</td>
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<td></td>
<td></td>
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<td>1.4 million cases of hydrocele</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>800,000 cases of lymphedema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevention of progression from subclinical to clinical disease</td>
<td>9.5 million people</td>
<td>6.0 million cases of hydrocele</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5 million cases of lymphedema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevention of worsening of morbidity or reversal</td>
<td>2.3 million people</td>
<td>1.2 million cases of hydrocele</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1 million cases of lymphedema</td>
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<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>800,000 cases of lymphedema</td>
<td>2.8 million DALYs</td>
<td></td>
</tr>
<tr>
<td>Prevention of progression from subclinical to clinical disease</td>
<td>9.5 million people</td>
<td>6.0 million cases of hydrocele</td>
<td>14 million DALYs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5 million cases of lymphedema</td>
<td>12 million DALYs</td>
<td></td>
</tr>
<tr>
<td>Prevention of worsening of morbidity or reversal</td>
<td>2.3 million people</td>
<td>1.2 million cases of hydrocele</td>
<td>? million DALYs</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1 million cases of lymphedema</td>
<td>? million DALYs</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>&gt;32 mil DALYs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Health Impact of GPELF

‘Beyond-LF’ benefits

Impact #3: Children treated for intestinal worms

Impact #4: Women of child-bearing age treated for hookworm

Impact #5: Debilitating skin diseases treated (Africa: oncho, scabies, lice)
Albendazole treatments to vulnerable populations, by region (2000-2008)

<table>
<thead>
<tr>
<th>Region</th>
<th>Total treatments to children ≤15</th>
<th>Individual children ≤15 treated</th>
<th>Total treatments to women of childbearing age</th>
<th>Individual women of childbearing age treated</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMRO</td>
<td>3,140,415</td>
<td>1,225,603</td>
<td>43,275,234</td>
<td>12,235,776</td>
</tr>
<tr>
<td>AFRO</td>
<td>61,029,461</td>
<td>17,604,672</td>
<td>2,281,764</td>
<td>889,207</td>
</tr>
<tr>
<td>EMRO</td>
<td>4,358,717</td>
<td>845,370</td>
<td>3,400,420</td>
<td>655,568</td>
</tr>
<tr>
<td>WPRO</td>
<td>26,274,089</td>
<td>5,572,699</td>
<td>21,744,901</td>
<td>4,605,564</td>
</tr>
<tr>
<td>SEARO</td>
<td>148,334,156</td>
<td>55,403,006</td>
<td>122,798,934</td>
<td>44,593,151</td>
</tr>
<tr>
<td>Total</td>
<td>243,136,838</td>
<td>80,651,350</td>
<td>193,501,252</td>
<td>62,979,266</td>
</tr>
</tbody>
</table>
# Health Impact of GPELF

‘Beyond-LF’ benefits

## 2000-2008

<table>
<thead>
<tr>
<th>Impact</th>
<th>Individuals Reached</th>
<th>DALYs Averted</th>
</tr>
</thead>
<tbody>
<tr>
<td>#3 Children: STH infections Rx’d</td>
<td>80.7 million</td>
<td>?</td>
</tr>
<tr>
<td>#4 Women of CBA treated for STH</td>
<td>63.0 million</td>
<td>?</td>
</tr>
<tr>
<td>#5 Debilitating skin disease Rx’d</td>
<td>60.6 million</td>
<td>?</td>
</tr>
<tr>
<td>Total</td>
<td>203 million</td>
<td>?</td>
</tr>
</tbody>
</table>
Economic Impact of GPELF (first 8 yrs)

- Quantifies economic benefits to:
  - Individuals infected or at-risk of LF
  - Health systems.

- Economic Benefit = Prevention of direct and indirect costs associated with LF clinical disease
  - Hydrocele, lymphedema, acute adenolymphangitis (ADL)
1. How many individuals gain economic benefits?

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Individuals infected with LF but protected from progression of disease</td>
<td></td>
</tr>
<tr>
<td>a. Subclinical disease</td>
<td>9.4 million</td>
</tr>
<tr>
<td>b. Clinical disease</td>
<td>19.3 million</td>
</tr>
<tr>
<td>2. Individuals protected from acquiring infection (and subsequent disease)</td>
<td></td>
</tr>
<tr>
<td>a. Newborns</td>
<td>2.2 million</td>
</tr>
<tr>
<td>b. Other individuals protected from infection</td>
<td>0.5 million</td>
</tr>
</tbody>
</table>

Total = 31.4 Million Individuals
2. What is the duration of economic benefits?

Discounted at 3% per year
Estimates use 2008 Net Present Value

Duration of Economic Benefits (person-years)

Start of MDA 2008 Avg. Life Expectancy

Economic Benefit Population Cohort

Discounted at 3% per year
Estimates use 2008 Net Present Value
3. What are the benefit parameters estimated for individuals infected or at risk of LF?

**Economic Benefit type:**

I. Direct financial costs prevented
   - *e.g.* medicines, doctor consultations

II. Indirect loss-of-labor costs prevented
   - *i.e.* reduced time spent on income generating activity

**Clinical Presentation type:**

I. Acute disease – adenolymphangitis (ADL)

II. Chronic disease – hydrocele and/or lymphedema
Economic Benefits Calculation

General formula calculated independently for each GPELF country to take into account country-specific estimates and years of program activity:

\[ TEB = \sum_{i=A}^{LE} \left( \frac{(BCP_{i-1}) \times (1 - M_i)}{(1 + D)^t} \right) \times (DC_{AD+CD} + IC_{AD+CD} + HS) \]

**Duration of Economic Benefit**  
**Population Size**  
**Economic Costs Prevented**

\[ TEB = \text{Total economic benefits (in US$2005)} \]
\[ LE = \text{Average life expectancy (years)} \]
\[ A = \text{Average age at time of MDA treatment (years)} \]
\[ M = \text{Annual mortality rate, age-specific} \]
\[ DC = \text{Direct costs prevented (US$2005)} \]
\[ IC = \text{Indirect costs prevented (US$2005)} \]
\[ BCP = \text{Benefit cohort population (2000-2007) (person-years)} \]

\[ AD = \text{Acute disease} \]
\[ CD = \text{Chronic disease} \]
\[ HS = \text{Health system costs prevented} \]
\[ D = \text{Annual discount rate (%)} \]
\[ t = \text{Time (Years beyond 2008)} \]
Economic Benefit
- following population cohort of first 8 years -

- Average of 6.5% of lost workdays prevented
- Up to 13% in some countries and populations

US$24 Billion
Economic Benefits, by WHO Region

- **SEARO**: $20.2 Billion
- **Rest of World**: $3.8 Billion
- **WPRO**: $2.2 Billion
- **AFRO**: $1.3 Billion
- **EMRO**: $0.1 Billion
- **AMRO**: $0.2 Billion
Projected Economic Impact of the GPELF

Total:
- AMRO: $0.7
- AFRO: $8.6
- EMRO: $0.5
- WPRO: $2.2
- SEARO: $20.2
- All: $31.1

Total Economic Benefit Achieved (US$ Billion): $0.9
Total Projected Economic Benefit Remaining (US$ Billion): $9.9

Total: $55.1
Economic Analysis

- The GPELF is an excellent investment in global health with impressive economic rates of return.

- The success of the GPELF, measured in economic terms, is a strong affirmation of the value of investing global health resources in targeting the NTDs.
**The New World Order**
Targeting NTDs through integrated programs

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<th>LF</th>
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Documenting both the *health impact* and the *economic impact* will be essential to ensure the future of GPELF and other programs targeting NTDs.