Africa’s Water-Borne Neglected Tropical Diseases: Problems Solved Innovations Proposed No Clue

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Millennium Development Goals

1. Eradicate extreme poverty and hunger.
2. Achieve universal primary education.
3. Promote gender equality and empower women.
4. Reduce child mortality.
5. Improve maternal health.
7. Ensure environmental sustainability.
8. Develop a global partnership for development.
The Neglected Tropical Diseases

Core Group

• Protozoan Infections
  – Human African Trypanosomiasis
  – Chagas Disease
  – Leishmaniasis

• Bacterial & Viral Infections
  – Buruli Ulcer
  – Dengue
  – Leprosy
  – Leptospirosis
  – Trachoma

• Helminth Infections
  – Soil-Transmitted Helminth Infections
    • Ascariasis
    • Hookworm Infection
    • Trichuriasis
    • Strongyloidiæs
  – Schistosomiasis
  – Lymphatic Filariasis
  – Onchocerciasis
  – FB Trematodiæs
  – Taeniasis/Cysticercosis
  – Echinococcosis
  – Dracunculiasis
Neglected Tropical Diseases (NTDs)

- Most prevalent infections of poor people
- Over ONE BILLION people infected worldwide

- Schistosomiasis 207 million
- Lymph Filariasis 120 million
- Dengue 50 million
- FB Trematodiases 40 million
- Onchocerciasis 37 million
- Buruli Ulcer 0.05 million
- Guinea Worm 0.01 million

Global Burden of NTDs

DISEASE
- Lower Respiratory Infections
- HIV/AIDS
- Unipolar Depression
- Diarrheal Disease
- Ischemic Heart Disease
- Neglected Tropical Diseases
- Cerebrovascular Diseases
- Malaria
- Road Traffic Accidents
- Tuberculosis

Per DALY Funding

$0.62
Impairment of intellectual and physical development in children

Adverse pregnancy outcome

Reduced productive capacity/worker productivity
Africa’s Major Waterborne NTDs

• Problem Solved – Guinea Worm
• Innovations Proposed – Schistosomiasis
• No Clue – Buruli Disease
Dracunculiasis – Guinea worm – geographical distribution 1980s

*Dracunculus medinensis*
Release into water of Guinea worm larvae – *Dracunculus medinensis*
Guinea worm – filtering drinking water to block transmission...the filter removes the copepods, intermediate hosts.
Dracunculiasis Elimination Program

• The Second Disease to be eradicated
  • >99% Reduction in Disease
  • 3.2 million cases in 1986
  • <100,000 cases in 2000
  • 16,000 cases in 2006
  • Sudan and Ghana
Global distribution of Schistosomiasis

**Senegal**
An epidemic of schistosomiasis along the Senegal river basin caused by water-resource development schemes continues unabated.

**Egypt**
Praziquantel chemotherapy coupled to a vigorous media campaign has resulted in a significant decrease in the morbidity and prevalence of schistosomiasis infection.

**Iran, Morocco, and Saudi Arabia**
Schistosomiasis control has been successful in those areas with elimination of the infection contemplated.

**China**
Schistosoma continues to be a major public health problem in the lake and marshy regions despite successful control in other endemic areas.

**Lao People’s Democratic Republic**
Schistosoma mekongi control has been successful around Khong Island with prevalence reduced from 42% to < 2%.

**North-east Brazil**
Urban schistosomiasis now present in and around many major cities.

**Ghana**
Intestinal schistosomiasis has increased due to the construction of the Akosombo Dam and other much smaller dams.

**sub-Saharan Africa**
More than 85% of the estimated 200 million people globally with schistosomiasis and the majority of patients with severe disease live on this continent.

**Indonesia**
Schistosomiasis has been controlled in the Lindu region of Sulawesi such that the prevalence of infection is lower than 2%.

**Djibouti and Somalia**
Displacement of people by war and instability has introduced intestinal schistosomiasis to these countries.
Water contact during collective fishing
Blood in urine from African schoolchildren
Rapid diagnosis of *S. haematobium*: Blood in urine
Age intensity profiles for schistosome infection

**S. haematobium** in Zimbabwe

**S. mansoni** in St. Lucia

**S. japonicum** in the Philippines
Schistosome Cercaria

Schistosome Eggs
Infection and disease due to *S. Haematobium* in Sub-Saharan Africa

<table>
<thead>
<tr>
<th>Condition</th>
<th>Estimated no. (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infections</td>
<td>111</td>
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<tr>
<td>Haematuria (blood in urine)</td>
<td>70</td>
</tr>
<tr>
<td>Major bladder wall pathology</td>
<td>18</td>
</tr>
<tr>
<td>Major hydrenephrosis</td>
<td>9.6</td>
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<tr>
<td>Death</td>
<td>0.2</td>
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</tbody>
</table>

From Van der Werf et al. 2003
Geographic distribution of Schistosoma mansoni infection

- **S. mansoni**
- **S. intercalatum**
“Hidden” Burden of Disease

- Anemia
- Chronic Pain
- Growth Retardation
- Cognition and Memory Loss
- Impaired Child Development
- Increased Susceptibility to HIV/AIDS
- Rapid Progression of HIV/AIDS
World Health Assembly Resolution 54.19

- Goal of attaining a minimum target of regular administration of chemotherapy to at least 75% and up to 100% of all school-age children at risk of morbidity by 2010

![Praziquantel](image)
6 countries receiving SCI support to control Schistosomiasis and intestinal helminths since 2003 + Burundi and Rwanda added in 2007

Niger
Mali
Burkina Faso
Uganda
Tanzania
Zambia
Burundi and Rwanda
The Solution: the Rapid Impact Package

- Albendazole (GSK) or Mebendazole (J&J)
- Diethylcarbamazine or Ivermectin (Merck)
- Praziquantel
- Azithromycin (Pfizer)

**US $0.50** all inclusive

**DRUGS**
- delivery
- equipment
- health education materials
- Training of personnel
- Monitoring and Evaluation

**US $0.50** per person per year

**BIG SEVEN NTDs**
- Ascariasis
- Trichuriasis
- Hookworm
- Lymphatic Filariasis
- Onchocerciasis
- Schistosomiasis
- Trachoma

**Bonuses:**
- Strongyloidiasis
- Trematodiases
- Taeniasis
- Scabies
Completed Genome Projects

- Buruli Ulcer
- Chagas Disease
- Human African Trypanosomiasis
- Leishmaniasis
- Leprosy
- Leptospirosis
- Lymphatic Filariasis
- Schistosomiasis
- Trachoma and Genital Chlamydia

Expressed and purified extracellular loop 2 as soluble fusion proteins with *E. coli* thioredoxin.
Schistosomiasis

207 million cases worldwide
180 million in Africa
4.5 million DALYs
280,000 Deaths Annually

Bilhvax®
Sh28GST + Alum
Institut Pasteur
Clinical Trials Senegal/Niger

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Distribution of Buruli
Buruli Ulcer

- Vector borne disease?
- Neutralize Mycolactone Toxin?
- Phage display library?
- Vaccine – The ultimate orphan product?