MARKET ASSESSMENT FOR MALARIA VACCINES

January, 2005

The Boston Consulting Group
ACKNOWLEDGEMENTS

Malaria market assessment study sponsored by

With funding from

[logos of Malaria Vaccine Initiative, USAID, and Bill & Melinda Gates Foundation]
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• Malaria burden
• Public market
• Private market

Travelers and military findings

Demand model methodology

Predicted vaccine market size

Implications and next steps

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OVERALL STUDY OBJECTIVE: ACHIEVING BETTER UNDERSTANDING OF THE DEMAND FOR MALARIA VACCINES

<table>
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<th>Project objectives</th>
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<tr>
<td>Create platform of knowledge that connects scientists, industry leaders, and donors with end users in countries afflicted by malaria</td>
</tr>
<tr>
<td>- Critical to ensure that what gets developed is what countries want</td>
</tr>
<tr>
<td>- Make need for vaccine concrete in eyes of industry donors</td>
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</tbody>
</table>

| Obtain more complete information about the need for a malaria vaccine to inform decision making and throw light on the decision-making “black-box” |
| - Understand hurdles and constraints to enable most rapid uptake possible |
| - Evaluate key risks and uncertainties |
|   - manufacturing capacity and capital investments required |
|   - design of clinical trials |
|   - “fair value” agreements |
|   - portfolio management |
|   - how to attract biopharma companies to invest in malaria vaccine R&D |

Project stems from MVI’s mission to accelerate the development of promising malaria vaccine candidates and to ensure their availability in the developing world.
INCLUDES PUBLIC AND PRIVATE MARKETS IN MALARIA-ENDEMIC AREAS OVER TIME AND ACROSS DIFFERENT POSSIBLE PRODUCTS

Project scope covers broad range of populations and endemic geographies from 2010 to 2025

<table>
<thead>
<tr>
<th>Geography</th>
<th>Population</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>Endemic - Public market</td>
<td>Military</td>
</tr>
<tr>
<td>SE Asia</td>
<td>Endemic - Public market</td>
<td>Travelers</td>
</tr>
<tr>
<td>South America</td>
<td>Endemic - Public market</td>
<td></td>
</tr>
</tbody>
</table>

Flexibility built into design so that project broadly relevant for malaria vaccine community

Analysis for malaria vaccines in general, not for any one specific vaccine

- Overall evaluation of demand drivers and adoption hurdles
- Includes demand forecasting and “tipping points” for various product profile scenarios (e.g., duration, efficacy, cost)

Market assessment conducted at one point in time, but structure allows ongoing insights to be developed as new information becomes available

- Attributes of a vaccine
- Attitudes with respect to particular product profile requirements
- Funding available for malaria
PROJECT DRIVEN BY
DEMAND LEAKAGE FRAMEWORK

Need                                      | Product                                    | Access                                     | Attitude
---                                         | ---                                       | ---                                         | ---
Number of people who would benefit          | Number of people for whom this vaccine     | Number of people with access to medical     | Number of people likely to get vaccinated
from a malaria vaccine                      | suitable                                   | care and able to pay for vaccination        | given government/personal stance and
                                                                                     |                                         | vaccination strategies

**Description**

- Number of people likely to get vaccinated given government/personal stance and vaccination strategies
- Number of people with access to medical care and able to pay for vaccination
- Number of people for whom this vaccine suitable
- Number of people who would benefit from a malaria vaccine

**Example factors**

- **Need**
  - Size of population with significant malaria mortality and disease burden
  - Size of traveler population
  - Size of relevant military population

- **Product**
  - Species (P. falciparum or P. vivax)
  - Pediatric indication

- **Access**
  - Country healthcare expenditure per capita
  - Infrastructure, e.g., beds per 1000 people
  - Percent of children under 12 vaccinated for measles

- **Attitude**
  - Government support of current prevention and treatment
  - Individual compliance with current prevention and treatment
DEMAND LEAKAGE FRAMEWORK IMPLEMENTED VIA THREE-PHASED APPROACH
Conducted Across Both Endemic Countries and Special Populations

Objective

Situation analysis for endemic countries and select populations

Key activities

- Review secondary sources for endemic countries (e.g., malaria burden, EPI uptake, demographics)
- Identify and study analogs
- Perform cluster analysis to segment countries
- Generate product profile for primary research

Evaluation of demand drivers and barriers

- Primary research in 8 endemic countries
- Primary research with travel medicine specialists and military experts
- Primary research with donors, policymakers, and KOLs

Synthesize findings and construct demand model

- Conduct additional interviews as necessary
- Synthesize findings
- Develop interactive model to estimate vaccine demand
- Run scenarios and sensitivities on model output

Project completed over 20 weeks in 2004-5
PRIMARY INTERVIEWS FOCUSED ON MALARIA-ENDEMIC REGIONS ACROSS THE GLOBE
Included Both P. vivax and P. falciparum Endemic Regions

Malaria-endemic regions are geographically concentrated

P. falciparum of increasing importance in Africa and SE Asia

Africa dominated by P. falciparum
- 5 to 10% of cases are P. vivax
- Increasing drug resistance to this more severe species makes P. falciparum a focus area

Growing importance of P. falciparum in India
- 20% of cases in 1980 to 45% in 2000

P. falciparum accounts for nearly 80% of cases in the Mekong region of SE Asia

Eastern Europe, Caucasus, and Brazil predominantly P. vivax

Note: WHO Southeast Asia Regional Office estimates that 70-75% of malaria deaths are from Sub-Saharan Africa due to changing malaria conditions and under-reporting.

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EIGHT LOCATIONS CHOSEN TO MAXIMIZE EXPOSURE TO NEED, ACCESS, AND ATTITUDES OF MALARIA-ENDEMIC COUNTRIES

Countries chosen to balance selection across key criteria

Over 200 interviews conducted

Need:
- Population at risk
- Malaria burden
- Transmission setting

Quadrant I: Moderate potential demand?
Country A
Country B
Country C

Quadrant II: High potential demand?
Country C

Quadrant III: Moderate potential demand?
Country G
Country H
Country D
Country E

Quadrant IV: Low potential demand

Access/attitude:
- Malaria readiness
- Health care expenditure
- Number of physicians
- Presence of clinical site
- Geography / culture

P. falciparum predominant
P. vivax and P. falciparum predominant
P. vivax only predominant

Note: Complete list of interviewees can be found in the appendix
70983-02-DC Meeting-Handout-18Jan05-BW-BOS.ppt

P. falciparum predominant
P. vivax and P. falciparum predominant
P. vivax only predominant

Primary research countries

Brazil
Ghana
India
Mozambique
Nigeria
Senegal
Thailand
Tanzania

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IN ADDITION, PRIMARY RESEARCH CONDUCTED WITH DONORS, POLICYMAKERS AND MILITARY AND TRAVELERS EXPERTS

More than 200 in-country and 30 global interviews conducted

Note: Complete list of interviewees can be found in the appendix
FINDINGS INCORPORATED INTO AN ADAPTIVE MODEL USED TO PREDICT VACCINE DEMAND

Sample Information Flow – Does Not Represent Full Scope of Model

<table>
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<tr>
<th>Scenario drivers</th>
<th>Model logic</th>
<th>Modular outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>Data inputs</td>
<td>Demand over time</td>
</tr>
<tr>
<td>Duration</td>
<td>Attitudinal inputs</td>
<td>2010 2011 2025</td>
</tr>
<tr>
<td>Cost</td>
<td>Attitudinal algorithms</td>
<td>Demand by geography</td>
</tr>
<tr>
<td>Funding</td>
<td></td>
<td>Africa SE Asia S America</td>
</tr>
</tbody>
</table>

- Model has flexibility to accommodate changes in vaccine landscape and country characteristics over time

- Model logic inputs:
  - Age, birth cohort
  - GDP, income
  - Malaria incidence

- Model logic algorithms:
  - Include country X if efficacy > Y
  - Include military if duration > Z
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**MALARIA IS ONE OF THE WORLD’S MOST COMMON AND MOST DEADLY PARASITIC DISEASES**

**Population at risk** – malaria is endemic in 117 countries; 2.5 B people are at risk (40% of world’s population)

**Morbidity** – malaria infects a minimum of 300 to 500 MM people per year

**Mortality** - between 1 and 2 MM people die annually from malaria, mostly children under 5 in rural areas

**Health care** – at least 10% of hospitalizations and 20-60%\(^{(1)}\) of doctor visits in Africa are caused by malaria

**Costs** – real costs in Africa are $1.8 B annually; lost GDP of $12 B per year due to malaria

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\(^{(1)}\) WHO estimates 20-30%, but in-country primary research cites 40-60%
Source: WHO 2002

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(Images and diagrams related to Malaria transmission cycle and basic facts)
**PRIMARY MALARIA BURDEN DRIVEN BY P. FALCIPARUM AND P. VIVAX**

P. falciparum Increasing Its Impact Across Both Asia And Africa

<table>
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<th>Plasmodium characteristics</th>
<th>In addition to its prevalence in Africa, P. falciparum also dominates in Mekong region of SE Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>P. falciparum</strong></td>
<td><strong>Malaria cases in 2003 (000s)</strong></td>
</tr>
<tr>
<td>• Infection can develop suddenly and produce several life-threatening complications</td>
<td>Myanmar and Vietnam together contribute to ~60% of malaria cases in the Mekong region</td>
</tr>
<tr>
<td>• Almost always treatable if treatment started promptly</td>
<td><strong>P. vivax</strong></td>
</tr>
<tr>
<td>• Infects RBCs in all stages of development</td>
<td>Myanmar: 14, Vietnam: 34, Cambodia: 29, Laos: 7, Thailand: 2, China/Yunan: 289, Total: 289</td>
</tr>
<tr>
<td><strong>P. vivax</strong></td>
<td><strong>Myanmar and Vietnam together contribute to ~60% of malaria cases in the Mekong region</strong></td>
</tr>
<tr>
<td>• Geographically widest spread, yet mostly found in the tropics, especially throughout Asia</td>
<td><strong>P. malariae</strong></td>
</tr>
<tr>
<td>• Relapses for up to 3 years possible, and chronic disease is debilitating</td>
<td><strong>P. ovale</strong></td>
</tr>
<tr>
<td>• Infects only young RBCs</td>
<td>Myanmar: 14, Vietnam: 34, Cambodia: 29, Laos: 7, Thailand: 2, China/Yunan: 289, Total: 289</td>
</tr>
<tr>
<td>• More likely to affect both adults and children</td>
<td>Rarity, and generally occurs in West Africa</td>
</tr>
</tbody>
</table>

**P. falciparum of growing concern in both Africa and Asia due to increasing drug resistance**


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<td>Demand model methodology</td>
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<td>Appendix</td>
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ENDEMIC COUNTRY DEMAND LARGELY DRIVEN BY PUBLIC MARKET

**Public market**
- Population of endemic country
- Product profile
- Coverage of target pop.
- Decision making and attitudes of government, KOLs

**Private market**
- Population of endemic country
- Product profile
- Private clinic access
- Individual attitudes

**Travelers**
- Travelers to endemic countries
- Product profile
- Seek advice before traveling
- Prefer vaccine vs. prophylaxis

**Military**
- Worldwide militaries
- Product profile
- Military budget
- Vaccinate all vs. deploying vs. none
THROUGHOUT OUR PRIMARY RESEARCH, STAKEHOLDERS RECOGNIZED THE SIGNIFICANT IMPACT OF MALARIA

Malaria is...

...a primary health issue

“...one of the most important vector borne diseases in Thailand” – MoPH Thailand

“...the most important vector borne disease from a public burden perspective in India” - NVBDCP

“...the primary public health crisis in Senegal” – BASICS Senegal

...a high cost burden

“...estimated to result in productivity loss of 1 – 3 % of GDP” – Ghana MoH

“...estimated to cost US$ 1 Bn per year to the country in terms of economic productivity” – Nigeria Dept of Public Health

...a huge problem - Mozambique MoH

Note: NVBDCP stands for National Vector Borne Disease Control Program
Source: BCG interviews, BCG analysis

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THE UBIQUITOUS NATURE OF THE DISEASE IN AFRICA PRESENTS A UNIQUE SET OF ISSUES

Malaria is so common in Africa that it can lead to complacency
- Frequency of deaths desensitizes the population
- Long history of the disease results in health workers feeling it is routine

"People accept it as part of life" – DFID
"The frequency of child deaths is so high that it is commonplace" – World Vision Senegal

Those hardest hit by malaria in Africa, are often disenfranchised
- Infants, young children, and pregnant women, who lack semi-immunity of adults, are most affected
- These groups have the smallest voice in health policy

"Children, who are worst affected by malaria, do not have a voice in the political system" – Ghana Health Service
"Malaria primarily targets children and pregnant women, who are not the decision-makers" – Mozambique MoH

Malaria is being overshadowed by HIV, particularly in East Africa
- HIV/AIDS hits adults much harder than malaria
  - though malaria is often the cause of death
- HIV/AIDS receives a greater share of health funds

"A lot of money is being poured into HIV/AIDS" – World Bank Tanzania
"There's a limited pot of money for healthcare, and HIV is attracting the resources" – UNICEF Moz.

As a result, malaria can lack the human capital, financial resources, and political energy it might warrant based on its impact

Source: BCG interviews, BCG analysis
IN COUNTRIES SUCH AS INDIA, THAILAND AND BRAZIL, THE IMPACT OF MALARIA IS MORE CONTAINED

Malaria is a problem in India, though high burden areas are geographically concentrated

“~10 – 15% of the population is at sufficient risk from malaria to warrant intensive control programs” – WHO

“Malaria control is the oldest and largest national vertical health program in the country” – MoHFM India

Malaria also a problem in Thailand and Brazil, but morbidity is now low and the disease burden has been restricted to border areas

“We saw malaria incidence rising in the 1990s, so in 1999 we decided to make this a priority” – MOH, Brazil

“Reported malaria cases were close to 500,000 cases in 1980s, but now are less than 30,000 a year” – Trop. Med. Thailand

“Malaria in Thailand is now well-controlled, except in the Thai-Myanmar and Thai-Cambodia border regions” – Trop. Med. Thailand

But the concentration of malaria in border or remote locations in these countries can create a different set of political challenges for diagnosis, prevention and treatment

Source: BCG interviews, BCG analysis
CURRENT INTERVENTIONS COMBINE PREVENTION AND TREATMENT

**Prevention includes spraying, environmental cleaning, ITNs and IPT**

- **Spraying**: outdoor and indoor based on vector resting location
- **Environmental clean-up**: removal of standing water; seeding of larvivorous fish
- **ITNs**: insecticide treated bed nets for children < 5 and pregnant women
- **IPT**: intermittent presumptive treatment for pregnant women, IPTi for infants

**Treatment focuses on early recognition and accurate diagnosis and treatment**

- **Early recognition**: Educate patients to recognize symptoms early and promptly seek treatment
  - Education in schools, health facilities
  - Home info packets
- **Accurate diagnosis**: Ensure correct diagnostic techniques are available
  - Increasing access to health facilities (clinics, ambulances, pharmacies)
- **Accurate treatment**: Drug therapy according to resistance of the region and plasmodium species
  - CQ often limited by resistance
  - SP often first-line, but facing growing resistance
  - ACT use increasing, but facing supply problems

**Portfolio approach to intervention likely to continue**

Source: BCG interviews, BCG analysis, WHO Africa Malaria Report 2003
# Focus on Prevention vs. Treatment Varies by Geography

Most African Countries Emphasize Prevention while More Developed Countries Promote Early Diagnosis and Treatment

<table>
<thead>
<tr>
<th>Area</th>
<th>Strategy</th>
<th>Population at risk and attitude</th>
<th>Donor perspective</th>
<th>Prevention</th>
<th>Diagnosis and treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td></td>
<td>• Children under 5 and pregnant women most vulnerable&lt;br&gt;• Majority of country&lt;br&gt;• Common disease: part of daily life</td>
<td>• Some funds for subsidized ITN, IPT, ACT, etc</td>
<td>• ITN subsidies&lt;br&gt;• IPT with SP piloted&lt;br&gt;• Lower focus on spraying and clean-up</td>
<td>• First line varies (CQ, SP and Amodiaquine) facing resistance&lt;br&gt;• Shift to ACTs&lt;br&gt;• Limited diagnostic equipment</td>
</tr>
<tr>
<td>SE Asia</td>
<td></td>
<td>• Adults and children&lt;br&gt;• Biggest problem in border areas&lt;br&gt;• Focus of local govt</td>
<td>• Wealthier countries less reliant on donor support</td>
<td>• Residual spraying in selected districts&lt;br&gt;• Use of larvivorous fish to control vector</td>
<td>• Rapid diagnosis / presumptive treatment based on geography&lt;br&gt;• High resistance; some must use ACT first line</td>
</tr>
<tr>
<td>South America</td>
<td></td>
<td>• Adults and children&lt;br&gt;• Biggest problem in border areas&lt;br&gt;• Perceived to be “under control”</td>
<td>• Wealthier countries less reliant on donor support</td>
<td>• Spraying &amp; clean-up in high risk/border areas&lt;br&gt;• No ITN, indoor spray due to outdoors-resting vector</td>
<td>• Faster response from diagnostic facilities&lt;br&gt;• Species specific treatment&lt;br&gt;• Goal: treatment within 24 hours</td>
</tr>
</tbody>
</table>

**Difficulty in controlling malaria burden, especially in Africa**

Source: BCG interviews, BCG analysis
SIX CHARACTERISTICS OF PRODUCT PROFILE ARE KEY DEMAND DRIVERS

- Efficacy
  - Clinical
  - Severe

- Duration of action

- Targeted species
  - P. falciparum
  - P. vivax
  - Other

- Population
  - Age
  - Pregnancy
  - Other diseases

- Administration
  - Dosage
  - Schedule
  - Boosters

- Cost

Source: BCG interviews, BCG analysis
PUBLIC MARKET VACCINE MUST BE COST EFFECTIVE, FINANCIALLY SUSTAINABLE, AND EASY TO ADMINISTER

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Impact on demand</th>
<th>Details</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>High</td>
<td>• Minimum efficacy desired against clinical disease vary from 30% in W Africa to 50% in E Africa to 80% in SE Asia</td>
<td>Countries will compare efficacy against ITNs and other preventative tools</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Duration factors into cost effectiveness - minimum of 1 year</td>
<td>Benefit of protecting children early in life, until they develop partial immunity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Cost/efficacy needs to compete with existing interventions</td>
<td>Duration impacts cost</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• May require donor funding, but countries need sustainable solution</td>
<td>Financial sustainability a huge issue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• P. falciparum most important in Africa and Asia vs. P. vivax in Brazil</td>
<td>We’re most concerned about P. falciparum—it is the most deadly</td>
</tr>
<tr>
<td>Duration</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>High</td>
<td>• Relevant to infants, children, and pregnant women in Africa vs. adults in SE Asia, S America</td>
<td>Pregnant women and under fives are highest priority</td>
</tr>
<tr>
<td>Species</td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population segment</td>
<td>Low</td>
<td>• Prefer to give vaccine with existing EPI schedule</td>
<td>Only realistic way to implement vaccine is through EPI schedule</td>
</tr>
<tr>
<td>Administration</td>
<td>High</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: BCG interviews, BCG analysis

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STAKEHOLDERS ACROSS COUNTRIES AGREE ON REQUIREMENTS FOR CERTAIN PRODUCT PROFILE CHARACTERISTICS

Malaria Endemic Countries

Duration

Most stakeholders agree that ~1 year minimum acceptable
  • Yearly boosters acceptable, but bring significant concerns for costs and compliance in rural and border populations
    - booster frequency will impact cost/benefit assessment
    - extending duration to 2 years could significantly increase coverage and reduce costs

Administration

Almost universal view that vaccine should be included in EPI program
  • Most prefer adhering to existing EPI timing
    - some openness to changing schedule for efficacious vaccine
  • Vaccination campaigns may be used in Thailand and Brazil to reach adult target population
  • Injection not an issue, although oral is preferred and would increase compliance

Safety

Across all countries, safety universally important but also “assumed”

Source: BCG interviews, BCG analysis
VACCINE RELEVANT FOR HIGH-RISK POPULATIONS IN AFRICA VS. TOTAL POPULATION IN HIGH-RISK AREAS IN SE ASIA / S AMERICA

**Africa**
- Entire countries considered malaria-endemic
- Adults develop partial immunity to disease
  - children under five and pregnant women in greatest need
  - government cover for adults unlikely
- HIV positive adults priority in some countries

**SE Asia / S America**
- In Brazil, Thailand, India, etc, malaria only present in border areas
- Vaccine considered relevant and appropriate for all age groups in India and Brazil and primarily adults in Thailand

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**Population**

**Tanzania**
- Vaccine relevant to children under 5 throughout country

**Brazil**
- Vaccine relevant to all age groups in Amazon area

---

Note: SE Asia / S America represented in interviews by India, Thailand, and Brazil
Source: BCG interviews, BCG Analysis
# EFFICACY AND COST HURDLES DIFFER FOR AFRICAN COUNTRIES VS. SE ASIA / S AMERICA

Africa Typically Has Lower Efficacy Requirement and Higher Cost Sensitivity

<table>
<thead>
<tr>
<th><strong>Efficacy</strong></th>
<th><strong>SE Asia / S America</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Impact on clinical disease critical</em></td>
<td><em>Impact on clinical disease very important</em></td>
</tr>
<tr>
<td><em>Impact on severe disease may not influence introduction decisions</em></td>
<td>- Thailand focused on severe disease efficacy due to increasing drug resistance</td>
</tr>
<tr>
<td><em>RTS,S data viewed as promising</em></td>
<td><em>P. falciparum more important to India and Thailand; P. vivax more important to Brazil</em></td>
</tr>
<tr>
<td><em>W. Africa hurdle: ~30% against clinical and ~50% against severe disease</em></td>
<td><em>Hurdle: ~80-90% against clinical disease</em></td>
</tr>
<tr>
<td><em>E. Africa hurdle: ~50% against clinical</em></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Cost</strong></th>
<th><strong>Cost</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Population expects vaccine to be free</em></td>
<td><em>Wealthier governments expected to purchase vaccine; donors important in poorer nations</em></td>
</tr>
<tr>
<td>- majority of population cannot afford even $1-3/dose</td>
<td>- Thailand: $10-20 / dose affordable</td>
</tr>
<tr>
<td><em>Governments will evaluate cost effectiveness of vaccine vs. malaria control portfolio</em></td>
<td>- India: cost of rolling out to even high risk groups would be prohibitive</td>
</tr>
<tr>
<td><em>Donor funding critical</em></td>
<td><em>Governments will evaluate cost/benefit of vaccine vs. malaria control portfolio</em></td>
</tr>
<tr>
<td><em>Some countries will refuse upfront financing without clear path to sustainability</em></td>
<td><em>Some countries will refuse upfront financing without clear path to sustainability</em></td>
</tr>
</tbody>
</table>

Note: SE Asia / S America represented in interviews by India, Thailand, and Brazil

Source: BCG interviews, BCG Analysis
ENDEMIC COUNTRIES’ ABILITY TO PURCHASE VACCINE IS HEAVILY CORRELATED WITH DONOR FUNDING

Developing economies rely heavily on donor funding for health programs

- Many African and SE Asian countries fund a majority of their budgets with donor support
- High disease burden in these countries translate to large amounts of funding dedicated towards the health budget

"The general funds that the Senegal MoH uses to fund its operations can come from international donors like the World Bank or the EU"

More developed economies receive (and need) less donor support

- Developed economies cover most of their budgets with internal funds
- Organizations such as the World Bank are less likely to give low-cost loans to developed economies

"~ 50% of our overall budget and more than 50% of health spending is donor-funded"

"Thailand is now considered a well established economy and ‘too rich’ to need outside support" – NSTDA

"In India, NGOs and donor organizations have a very limited role in malaria control; less than 5% of expenses for malaria are from donors"

Funding sustainability will drive demand for less wealthy countries

Source: BCG interviews, BCG analysis
FUNDING DECISIONS MADE VIA ITERATIVE PROCESS, OFTEN BASED ON WHO GUIDELINES AND KOL RECOMMENDATIONS

Key influencers besides WHO, UNICEF, GAVI, and the MoH are university professors and academics – NGO, Senegal

There are targets for high-priority sectors like health – NGO, Mozambique

General Funding Methodology

Donor strategies and priorities
Technical recommendations from WHO and KOLs

Budget Requests
Countries MOH/MOF and/or local donor offices make requests to headquarters

Local offices make funding requests ~2 years in advance of expected receipt - USAID

Early Allocations
Based on requests, priorities, and budget, early allocations are made into broad spending categories

It’s all about information; sometimes the countries don’t know what will and won’t be approved - Global Fund

Negotiations with countries, organizations
Countries and/or local donor offices negotiate needs, allocation, and timing with headquarters

Regional teams determine priorities and resource allocation for each country through negotiation with MOF, MOH, and other local planning groups - WB

Final allocations
Final grants are made to countries and organizations

The local office works with national government to allocate money within country to highest need areas - UNICEF

Highly collaborative approach translates to donors making few independent evaluations of new technologies or interventions

Source: BCG interviews, BCG analysis

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MALARIA VACCINE SEEN AS PROMISING, BUT WOULD SHARE AVAILABLE DONOR RESOURCES WITH EXISTING INTERVENTIONS

Donors are highly interested in a vaccine...

- Donors routinely cite a vaccine as a very exciting possibility
- Donors fund significant amounts of vaccine R&D

"DFID maintains an active interest in vaccine research" - DFID

"A vaccine will be a very attractive investment for the donor community" - USAID

...but total funding unlikely to increase drastically

- Total malaria and vaccine funding may not change with partial efficacy vaccine

"There is only one pot of money for all healthcare interventions" - UNICEF

"USAID dollars given to the Vaccine Fund will likely not increase in response to a new malaria vaccine" - USAID

..and current solutions are unlikely to disappear

- Current tactic of portfolio approach to malaria unlikely to disappear with vaccine introduction

"No one measure is a magic bullet—need to work with what we have" - USAID

"We would not want to see a vaccine hindering the use of ITNs; the world has worked so hard to get people to use them" - USAID

Allocation of funding within prevention and control portfolio likely to be determined by vaccine product profile

Source: BCG interviews, BCG analysis
EXISTING EPI COVERAGE SHOWS NUMBER OF PEOPLE POTENTIALLY VACCINATED
EPI Program Is An Effective Tool For Reaching Vaccine Recipients

Source: BCG interviews, BCG Analysis, SIS for DPT-3 coverage
**EVEN WITH DONOR FUNDING, SOME CONCERN ABOUT KEY STAKEHOLDERS WILLINGNESS TO ACCEPT A MALARIA VACCINE**

8 Reasons Commonly Cited

<table>
<thead>
<tr>
<th>Reasons for Reduced Interest</th>
<th>Rationale</th>
<th>Relevant Geographies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 No need for a vaccine</td>
<td>Countries with better control over malaria may view need for a vaccine as less urgent</td>
<td>Brazil, Thailand</td>
</tr>
<tr>
<td>2 Do not trust vaccine due to prior failure</td>
<td>Community may be less willing to support a new malaria vaccine based on history of SPF66</td>
<td>Thailand; Africa—high awareness, but less impact due to high burden</td>
</tr>
<tr>
<td>3 Inadequate infrastructure</td>
<td>Pragmatic concerns regarding ability to reach population, i.e. staff training, cold chain needs, etc.</td>
<td>Mozambique, Tanzania, Nigeria; likely an issue throughout Africa</td>
</tr>
<tr>
<td>4 Do not want to spend for non-nationals</td>
<td>Government unlikely to unilaterally spend money on malaria control for migrants and refugees</td>
<td></td>
</tr>
<tr>
<td>5 Need local data to prove effectiveness</td>
<td>Some countries emphasize importance of testing the vaccine in-country</td>
<td>Most countries</td>
</tr>
<tr>
<td>6 Difficult decision making</td>
<td>States or regions highly autonomous in decision-making, particularly regarding health interventions</td>
<td>Nigeria, India</td>
</tr>
<tr>
<td>7 Partial efficacy vaccine may decrease credibility</td>
<td>Vaccinated people who contract malaria could decrease credibility of entire immunization program</td>
<td>Most countries</td>
</tr>
<tr>
<td>8 Partial efficacy vaccine complicates messaging</td>
<td>Must communicate benefit of partial efficacy in promotion materials and to trainers</td>
<td>Most countries</td>
</tr>
</tbody>
</table>

Most hurdles can likely be addressed through effective pre-launch planning, proactive stakeholder management, and communication.

Source: BCG interviews, BCG analysis.
INFLUENCE OF GOVERNMENT, KOLS, DONORS, AND NGOS DIFFERS BETWEEN AFRICA AND SE ASIA / SOUTH AMERICA

**Africa**
- Key role in vaccine introduction
- Health investment decisions made at highest levels of MoH, often with legislature input
- Local experts wield significant influence in Nigeria, Tanzania, Senegal
- Foreign experts stronger in Mozambique
- Key role in vaccine introduction
- Dependence varies by country
- E. Africa concerned with sustainability
- WHO plays key role
  - esp. in countries with less human capital
  - UNICEF, international researchers, GAVI, and others also can be very influential

**SE Asia / S America**
- Primary decision-maker for vaccine
- Long-standing MOH malaria programs
- Decentralization key trend, with local authorities playing an increasing role
- Strong research communities
- Demand for in-country clinical trials
- Thailand and Brazil: researchers sit on malaria committees to assist MoH with policy
- Highly self-sufficient
  - India funds ~95%, Brazil and Thailand fund close to 100% of malaria expenses
- WHO plays a key role, but less than in Africa
  - collaborates with govts. on research projects
- More limited role for other organizations

Coordinating influencers across geographies key to maximizing intervention supply

Note: SE Asia / S America represented in interviews by India, Thailand, and Brazil
Source: BCG interviews, BCG Analysis
KEY TAKEAWAYS
Public Market

Significant need for malaria vaccine in public market. Despite breadth of existing alternatives for prevention and treatment, control perceived to be insufficient in most countries

- Growing need for response to P. falciparum in non-African countries

Minimum product profile varies by geography, however consistent focus on importance of P. falciparum, one year duration, and safety

- Efficacy requirement highest for clinical disease in SE Asia (80%); lowest in W Africa (30%)
- Cost important as governments often do not have ability to pay for vaccine
  - and public often expects vaccine to be free of charge

Current vaccination infrastructures could support significant uptake – but, donor funding will be needed to finance vaccine purchase and infrastructure enhancement requirements in African countries

- Increasing focus on long-term sustainability of donor supported programs
- Wealthier SE Asian / South American countries willing to do more alone

African country governments and donors rely heavily on recommendations from global scientific community and WHO when making decision about vaccine introduction

- In wealthier SE Asian / South American countries, government and local stakeholders key

Hurdles vary across geographies, but include perception of need, perceptions of vaccines, communication and credibility issues for partial effective vaccines and desire for local clinical data
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<td>• Public market</td>
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<td>• Private market</td>
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<tr>
<td>Travelers and military findings</td>
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<td>Demand model methodology</td>
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<td>Implications and next steps</td>
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</tbody>
</table>
PRIVATE MARKET ALSO RELEVANT IN ENDEMIC COUNTRIES

PUBLIC MARKET
- Population of endemic country
- Product profile
- Decision making and attitudes of government, KOLs

PRIVATE MARKET
- Population of endemic country
- Product profile
- Private clinic access
- Individual attitudes

TRAVELERS
- Travelers to endemic countries
- Product profile
- Seek advice before traveling
- Prefer vaccine vs. prophylaxis

MILITARY
- Worldwide militaries
- Product profile
- Military budget
- Vaccinate all vs. deployed vs. none
## Private Market Most Concerned That Vaccine Be Highly Efficacious

### Attribute | Impact on Demand | Details | Comments
--- | --- | --- | ---
**Efficacy** | High | • Most important factor given need to proactively seek out vaccine; efficacy has to warrant the time and money invested | Private market acceptance likely with high efficacy

**Duration** | Medium | • Minimum one year |

**Cost** | Medium | • Cost less of an issue than in public market for wealthy individuals, but still significant for groups choosing among interventions

**Species** | High | • Vaccine for P. falciparum more important given severity of disease

**Population** | Medium | • Private market vaccine applicable to adults as well as other high risk groups

**Administration** | Low | • Individuals seeking a vaccine in the private market are more likely to comply with multiple doses / boosters

Source: BCG interviews, BCG analysis
PRIVATE MARKET LIKELY SMALL, EXCEPT IN MORE WEALTHY AND POPULOUS COUNTRIES SUCH AS INDIA

Extensive private market for vaccines in India

Private market for vaccines appears limited in other countries

70% of health care spend from private market; 2004 private vaccine market estimated at $65 MM

Private purchase of vaccines limited to the very high income class who prefer private facilities

Private market in African countries for a malaria vaccine likely to be small

Source: IMS
70685-02-DC Meeting-Handout-19Jan05-BW-BOS.ppt
HURDLES INCLUDE INADEQUATE INFRASTRUCTURE, LIMITED CLINIC ACCESS, AND REGULATIONS

Infrastructure
- Africa: private vaccination services obtained through private clinics often in large urban areas
- Brazil and Thailand regions limited to border areas with less private health care infrastructure
- Private shops selling pharmaceuticals exist in all primary research countries except Mozambique
  - usually do not distribute vaccines; may have more limited access to cold chain

Access
- Clientele of private clinics tends to be wealthy and urban, typically much less than 10% of total population

Regulation
- Regulations in several countries may impact viability of private vaccination markets
  - Mozambique: regulations limit sale of drugs/vaccines to select health facilities and pharmacies
  - Tanzania: regulations prevent private clinics from charging for EPI schedule vaccines

Nigeria likely to have the most robust private market of the African countries researched
- Even there, infrastructure challenges would need to be addressed to maximize reach

Source: BCG interviews, BCG analysis
PRIVATE MARKET ALSO LIMITED IN MANY MALARIA ENDEMIC COUNTRIES BY AFFORDABILITY AND EFFICACY CONSTRAINTS

Per capita GNI indicates country wealth...

...and ability of individuals to purchase a vaccine

While efficacy requirements are high across countries

- Efficacy hurdles for private market uptake likely to be higher than for public market
- Majority of private market likely to opt for alternative prevention over an expensive, low efficacy vaccine
- Wealthiest segment may purchase all available interventions - even expensive ones, such as residual spraying

1) Able to purchase vaccine defined as 2 weeks of annual income, based on country per capita levels and income distribution

Source: BCG interviews, BCG Analysis

The Boston Consulting Group
INDIVIDUAL ATTITUDES FURTHER LIMIT PRIVATE MARKET OPPORTUNITY EVERYWHERE EXCEPT INDIA

In Brazil, Thailand, Africa, cultural expectation is to obtain health services from government...

In primary research countries, standard vaccines are provided free of charge by the government
  • Similarly, malaria-related interventions are often also government-funded

In countries with a socialist history, private market for health services is relatively new
  • Paying for health services, or paying more for better service, has not been completely absorbed into the culture

For Brazil and Thailand, private health services are more common in higher-income areas; however, income levels in malaria endemic regions very low
  • Rely heavily on health services provided by government
  • Unlikely to be able to afford high-cost vaccines

...Whereas in India, private market is increasing

Emergence of urban malaria means higher socio-economic class is seeking private prevention and treatment for malaria

Large proportion of health care in India provided by private sector
  • Vaccines often obtained via private sector

Government health care infrastructure considered poor quality and inefficient

Indian middle and upper socio-economic strata (SEC A & B) primarily accesses health care from private sector
  - accounts for ~ 200 - 250 Mn people
  - annual birth cohort of ~ 5.5 – 6.5 MM

Significant uptake of vaccine in private market likely in India if efficacy hurdles can be met

Source: BCG interviews, BCG analysis
70685-02-DC Meeting-Handout-TBAand-BW-BOS.ppt
KEY TAKEAWAYS
Private Market

Product profile varies from public market requirement
  • Higher efficacy threshold given availability of alternatives (minimum 50%)
  • Administration restrictions lower due to routine doctor visits
  • Cost less sensitive than for public market

Access and wealth constraints limit private market to subset of populations
  • Wealthiest segment of population likely to purchase all relevant interventions
    - i.e. residual spraying along with ITNs, a vaccine, and ACT purchases
  • Only small fraction of remaining population can afford typical vaccine costs and this group will likely have to decide among interventions
    - i.e. only 0.03% of Nigeria privately purchases $12 Hep B vaccines
  • However, small fraction of large country is still a substantial population (~600,000 Indian citizens purchase Hep B)
  • Proximity to clinics and regulations on private sales of vaccines also limit demand
    - many countries have <300 clinics able to administer a private vaccine

Cultural expectation of publicly-provided health services translates to some individuals not seeking private vaccination, even if they can afford it
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  - Private market
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- Predicted vaccine market size
- Implications and next steps
- Appendix
TRAVELERS MARKET HAS EXTREMELY HIGH PRODUCT REQUIREMENTS

- **Need**
  - Public Market: Population of endemic country
  - Private Market: Population of endemic country
  - Travelers: Travelers to endemic countries
  - Military: Worldwide militaries

- **Product**
  - • Product profile

- **Access**
  - • Coverage of target pop.
  - • Donor funding
  - • Hurdles to adoption
  - • Private clinic access
  - • Income levels
  - • Seek advice before traveling

- **Attitude**
  - • Decision making and attitudes of government, KOLs
  - • Individual attitudes
  - • Prefer vaccine vs. prophylaxis
  - • Military budget
  - • Vaccinate all vs. deployed vs. none
**~147 MM TRAVELERS TRAVEL TO MALARIA ENDEMIC REGIONS**

22MM of These Are At-Risk For Malaria

---

### International tourist arrivals 2002

<table>
<thead>
<tr>
<th>Origin of Traveler</th>
<th>Americas</th>
<th>Europe</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>35</td>
<td>3</td>
<td>68</td>
</tr>
<tr>
<td>China</td>
<td>41</td>
<td>3</td>
<td>68</td>
</tr>
<tr>
<td>Asia</td>
<td>35</td>
<td>3</td>
<td>68</td>
</tr>
</tbody>
</table>

### Percent of travelers at-risk\(^{(1)}\) within endemic countries

<table>
<thead>
<tr>
<th>Destination</th>
<th>Americas</th>
<th>Africa</th>
<th>Asia</th>
<th>South America</th>
<th>Africa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>1</td>
<td>3</td>
<td>13</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>China</td>
<td>3</td>
<td>3</td>
<td>13</td>
<td>7</td>
<td>100</td>
</tr>
<tr>
<td>Asia</td>
<td>35</td>
<td>3</td>
<td>68</td>
<td>3</td>
<td>68</td>
</tr>
<tr>
<td>South America</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Travelers affected in malaria endemic countries

<table>
<thead>
<tr>
<th>Destination</th>
<th>Americas</th>
<th>Africa</th>
<th>Asia</th>
<th>Europe</th>
<th>Middle East</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>2.9</td>
<td>0.5</td>
<td></td>
<td>1.0</td>
<td>0.5</td>
</tr>
<tr>
<td>China</td>
<td>7.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asia</td>
<td>9.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{(1)}\)Countries clustered depending on traveler mobility within country (rural areas, jungle/bush, provinces with high indices of malaria)

Note: Malaria endemic countries defined by WHO. ‘developed world’ refers to travel from the Americas (South, Central, Caribbean, North America), Europe (Northern, Western Central/Eastern, Southern, East Mediterranean Europe) and Asia (North-East Asia, South-East Asia, Oceania, South Asia) as defined by WTO. It is important to note that not all travelers to malaria endemic countries will be traveling to regions with high malaria incidence within them.

INTERNATIONAL TOURISM TO ENDEMIC REGIONS PROJECTED TO INCREASE OVER THE NEXT 15 YEARS

Projected arrival forecast from developed world to high-risk areas of malaria endemic countries by destination region

Note: Malaria endemic countries defined by WHO, ‘developed world’ refers to travel from the Americas (South, Central, Caribbean, North America), Europe (Northern, Western Central/Eastern, Southern, East Mediterranean Europe) and Asia (North-East Asia, South-East Asia, Oceania, South Asia) as defined by WTO.


The Boston Consulting Group
MALARIA CASES AMONG U.S. TRAVELERS ARE DECREASING BUT INCIDENCE OF FALCIPARUM STRAIN IS INCREASING

Number of malaria cases reported by US travelers

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1402</td>
</tr>
<tr>
<td>2001</td>
<td>1383</td>
</tr>
<tr>
<td>2002</td>
<td>1337</td>
</tr>
</tbody>
</table>

Percentage of cases by plasmodium species

<table>
<thead>
<tr>
<th>Year</th>
<th>Undetermined</th>
<th>Mixed</th>
<th>P.Ovale</th>
<th>P. Malariae</th>
<th>P. Vivax</th>
<th>P. Falciparum</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>11</td>
<td>37</td>
<td>44</td>
<td>50</td>
<td>25</td>
<td>52</td>
</tr>
<tr>
<td>2001</td>
<td>13</td>
<td>28</td>
<td>50</td>
<td>52</td>
<td>25</td>
<td>52</td>
</tr>
<tr>
<td>2002</td>
<td>16</td>
<td>25</td>
<td>52</td>
<td>52</td>
<td>25</td>
<td>52</td>
</tr>
</tbody>
</table>

Note: Malaria cases confirmed by blood film are reported to local and state health departments by health-care providers or laboratory staff; number of cases probably underreported; “Imported malaria” refers to malaria acquired outside the U.S. and its territories

Source: CDC Malaria Surveillance Report 2002
GENERAL MALARIA PROTECTION IS HIGH AMONG TRAVELERS TO ENDEMIC REGIONS BUT MANY DO NOT TAKE CHEMOPROPHYLAXIS

Traveler general malaria prevention measures (1)

<table>
<thead>
<tr>
<th>Measure</th>
<th>U.S.</th>
<th>Europe</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clothing</td>
<td>93</td>
<td>90</td>
<td>83</td>
</tr>
<tr>
<td>Repellent</td>
<td>68</td>
<td>58</td>
<td>55</td>
</tr>
<tr>
<td>Doors Closed</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mosquito Net</td>
<td></td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>Insecticide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Conditioner</td>
<td></td>
<td>44</td>
<td></td>
</tr>
</tbody>
</table>

Traveler chemoprophylaxis use (2)

<table>
<thead>
<tr>
<th>Region</th>
<th>U.S.</th>
<th>Europe</th>
<th>Asia</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-risk malaria</td>
<td>78</td>
<td>44</td>
<td>3</td>
</tr>
<tr>
<td>endemic regions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-risk malaria</td>
<td>46</td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>endemic regions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Journal of Travel Medicine, Volume 11, Issue 01, 2004, January "Travelers' Knowledge, Attitude and Practices on the Prevention of Infectious Diseases". Interviews conducted in Johannesburg Airport. Inclusion Criteria: European residents on intercontinental flights. High-risk malaria destinations were tropical Africa, Papua New Guinea and the Solomon Islands with regional and seasonal exceptions. Low-risk malaria regions were endemic regions in Latin America, Asia and Southern Africa. 219 malaria and 200 vaccine preventable questionnaires were available for analysis.

(2) Journal of Travel Medicine, "Travel Health Knowledge, Attitudes and Practices among U.S. travelers" 404 respondents, interviews conducted in JFK airport among travelers going to target destination country identified as high risk. High risk countries for malaria were Ghana, Nigeria, Liberia, Tanzania and Kenya. Low-risk were: rural areas with known risk of malaria such as Brazil, Ecuador, DR, China, The Philippines, Thailand, Guyana and El Salvador. "Travelers Knowledge, Attitudes and Practices on Prevention of Infectious Diseases: Results from a Pilot Study" 609 responses from European travelers boarding flights to developing countries (Africa, Asia, excluding Japan and Singapore, and Latin America) "Travel Health Knowledge, Attitudes, and Practices among Australasian travelers" 21011 surveys conducted at five airports in Australasia, distributed to passengers from flights to countries in Asia, Africa, and South America. High risk malaria areas were all rural/jungle areas in Asian Countries except for Northern China, Singapore, Taiwan and Japan and all Sub-Saharan countries.
TIMING OF IMMUNIZATION AND DURATION OF TIME IN COUNTRY IS CRITICAL FOR A POTENTIAL MALARIA VACCINE

Only 30-50% of travelers plan at least 4-8 weeks in advance

Most travelers remain in destination < 2 weeks

Depending on profile, vaccine most useful for travelers who plan in advance and/or take long trips

ALTHOUGH TRAVELERS THINK HIGHLY OF VACCINES, FEW USE THEM TO PROTECT AGAINST INFECTIOUS DISEASES

Vaccine opinion rate high among travelers ...

<table>
<thead>
<tr>
<th>Origin of traveler</th>
<th>% of travelers who believe vaccines are important</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>74</td>
</tr>
<tr>
<td>Europe</td>
<td>80</td>
</tr>
<tr>
<td>Asia</td>
<td>76</td>
</tr>
</tbody>
</table>

...but Hep A uptake is low

<table>
<thead>
<tr>
<th>Vaccine uptake among travelers(1)</th>
<th>% of travelers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>22</td>
</tr>
<tr>
<td>U.S.</td>
<td>14</td>
</tr>
<tr>
<td>Asia</td>
<td>5</td>
</tr>
</tbody>
</table>

Variety of reasons drive low uptake

<table>
<thead>
<tr>
<th>Reasons travelers refused vaccination</th>
<th>% of travelers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at risk</td>
<td>25</td>
</tr>
<tr>
<td>Disliked vaccines</td>
<td>10</td>
</tr>
<tr>
<td>Vaccines are not important</td>
<td>4</td>
</tr>
</tbody>
</table>

Vaccine concerns included:
- Side effects
- Cost
- Pain
- Belief that they are useless

(1) Vaccine uptake information not available for all countries
Note: Hep A protection surveyed among travelers at risk of contracting the disease in country of destination, study methodologies in backup slides
## TRAVELER VACCINE UPTAKE DEPENDS ON ITS PROFILE

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Impact on demand</th>
<th>Details</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Efficacy    | High             | • Would need to be at least as efficacious as prophylaxis (98%)  
• Potential risk of misuse of standby treatment with lower efficacy  
• Previous low efficacy vaccine (cholera) had low uptake | “From a public health perspective, there is very low tolerance for risk with travelers” - CDC               |
| Duration    | Low              | • Short nature of “average trip” decreases importance of long duration vaccine                                                             | “A 30% efficacy vaccine is too low. It would be a hard sell” - Canadian KOL                                  |
| Cost        | Medium           | • Price sensitivity may depend on health-care system and drug coverage in home country  
• Cost relative to chemo-prophylaxis will likely drive demand  
• Travelers seem less price-sensitive if side effects of chemo-prophylaxis could be avoided | “Cholera vaccine has been highly ineffective” - CDC                                                          |
| Species     | Medium           | • Falciparum primary requirement for travelers  
• However, lack of vivax efficacy could hurt vaccine credibility or generate negative impressions | “Cost of treatment is a hurdle for a lot of people” - CDC                                                    |
| Administration | High          | • Time required between administration and departure will be key driver in vaccine usefulness given wide variation in planning habits observed | “There is a general public dislike to taking tablets - U.K.” - KOL                                            |
| Education   | High             | • Increasing population that seek pre-travel medical advice could heavily influence number that can receive vaccine  
• Traveler attitudes towards vaccines vs. tablets also important                                             | “People are still afraid of needles” - KOL                                                                 |

Source: BCG interviews, BCG analysis
KEY TAKEAWAYS
Travelers Market

Frequency of international travel to high-risk malaria areas is growing
- 22 MM arrivals in 2002 and 60 MM projected in 2020

Traveler behavior varies significantly in chemoprophylaxis use, pre-travel planning habits, duration of trips, and attitudes toward vaccines
- 78% of European travelers to high-risk malaria areas take prophylaxis vs. 46% of American travelers to high-risk malaria areas take prophylaxis
  - however, in low risk areas, prophylaxis use by Europeans lower than by Americans
- 30-50% of travelers plan trips 4-8 weeks in advance
- > 50% of travelers spend less than 2 weeks in destination region

Key demand drivers are efficacy, timing of immunization, education, duration of trip
- Vaccine must be as effective as available prophylaxis (~98%)
- Vaccine most useful if effective within a month of travel due to travel planning habits
- Market likely limited by number of people who seek pre-travel health advice from a physician
- Vaccine most useful for people who remain in destination for long periods of time (over 1 month)

Ultimate demand will depend on product profile trade-offs with available prophylaxis options
MILITARY MARKET ALSO HAS SPECIFIC PRODUCT REQUIREMENTS

Need | Product | Access | Attitude
---|---|---|---
Public market | Population of endemic country | Product profile | Coverage of target pop., Donor funding, Hurdles to adoption | Decision making and attitudes of government, KOLs
Private market | Population of endemic country | Product profile | Private clinic access, Income levels | Individual attitudes
Travelers | Travelers to endemic countries | Product profile | Seek advice before traveling | Prefer vaccine vs. prophylaxis
Military | Worldwide militaries | Product profile | Military budget | Vaccinate all vs. deployed vs. none
OVER 18 MM PEOPLE SERVE IN MILITARIES WORLDWIDE
US Leads In Military Spending

Militaries size and total expenditure

Note: Includes only militaries with over 50,000 active members and over $10,000 / member
TROOPS ARE CONTINUALLY DEPLOYED TO MALARIA-ENDEMIC REGIONS

US military deployments (1990-2004)

- Average % endemic: 6%

- Average length of deployment 110 days

UK military deployments (1997-2002)

- Average % endemic: 2%

- Average length of deployment 180 days

- Of US troops deploying to non-US locations from 1990-2004, 26% were sent to malaria endemic regions
- % of troops exposed to malaria endemic regions higher due to deployment cycles

Note: Malaria endemic defined as a country or region with any malaria.
Source: DASA, US DOD, Heritage, Malaria Foundation International; BCG interviews
MILITARIES FOCUS ON READINESS AND PREVENTING ILLNESS
Malaria Vaccine Has Potential To Maximize Both

“Once military personnel is sick, they are useless for a mission” - WRAIR

“The military’s main concern and what a vaccine would be mainly used for is to prevent illness” - KOL

“Focus is to prevent malaria, full-stop” – British Forces

“Soldiers need to be prepared to be deployed anywhere, if need be” – WRAIR

“Troops becoming unwell will affect operational capabilities...this is unacceptable” – British Forces

“Malaria control is seen as a fundamental performance metric of battalion commanders” - Indian Army
ILLNESS IS A SERIOUS ISSUE FOR MILITARIES
More Soldiers Die From Diseases Than from Wounds and Injuries

In Somalia and Operation Restore Hope, malaria was the No. 1 cause of casualties

Source: NIC (2000)
CURRENT TACTICS FOCUS ON PREVENTION, BUT COMPLIANCE ISSUES MEAN THAT MALARIA IS STILL A CONCERN

Three key preventative actions in US military

1. Personal Prevention
   - DEET
   - Uniform repellant
   - Protective clothing

2. Chemoprophylaxis
   - Choloroquine
   - Mefloquine
   - Doxycycline
   - Primaquine

3. Unit Protection
   - Bulk repellant
   - Camp selection
   - Mosquito surveys
   - Insecticides
   - Early diagnosis


Compliance drops largely due to long deployment times
- US deployments average 110 days, UK deployments average 180 days

Source: Dept. of Defense, Virtual Naval Hospital

THE BOSTON CONSULTING GROUP
70685-02-DC Meeting-Handout-19Jan05-BW-BOS.ppt
MILITARIES ACTIVELY VACCINATE THEIR TROOPS

All troops receive

United States
- Influenza
- Measles
- Meningococcal (A,C,Y,W-135)
- Mumps
- Polio
- Rubella
- Tetanus
- Diphtheria
- Hepatitis A

United Kingdom
- Meningococcal C
- Polio
- Tetanus
- Diphtheria
- Yellow Fever
- Hepatitis A
- Typhoid
- TB

Troops deploying to high risk areas receive

United States
- Yellow Fever
- Typhoid

United Kingdom
- Meningococcal A
- Japanese Encephalitis
- Rabies
- Encephalitis (tick)

United States
- Occupational Risk:
  - Hepatitis B
  - Plague
  - Rabies
  - Varicella
  - Small Pox
  - Anthrax

United Kingdom
- Occupational Risk:
  - Hepatitis B
  - Rubella

“Soldiers deployed to Korea had to take the anthrax vaccine, those travelling to Kuwait took the small pox vaccine, those going to Kenya received the yellow fever vaccine and some going to Asia received the JE vaccine” -WRAIR

“Soldiers deployed to Korea had to take the anthrax vaccine, those travelling to Kuwait took the small pox vaccine, those going to Kenya received the yellow fever vaccine and some going to Asia received the JE vaccine” -WRAIR

Comfort with vaccination as a prevention technique could drive demand for a potential malaria vaccine
- “The most efficient, cost-effective and easiest way to prevent any infectious disease is with a vaccine” –Naval Medical Research Institute

Source: Interviews, Institute of Medicine of the Natural Sciences, Naval Medical Research Institute
## MILITARY DEMAND HINGES ON VACCINE PROFILE

**Unique Set of Challenges For Military Markets**

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Impact on Demand</th>
<th>Details</th>
<th>Comments</th>
</tr>
</thead>
</table>
| Efficacy    | High             | • Efficacy against clinical disease most important  
               |       | - 50-80% threshold mentioned |
| Duration    | Medium           | • Duration will drive whether some or all troops receive a vaccine  
               |       | - 4-6 month minimum mentioned |
| Cost        | Split High/Low   | • Cost not an issue for high expenditure forces  
               |       | • Cost an issue for lower budget forces |
| Species     | Low              | • Military cannot afford to have anyone sick  
               |       | - species of disease not important  
               |       | - military affected by all species |
| Administration | Medium     | • 6 month window to reach recruits  
               |       | • 1 month window to reach deploying troops |
| Safety      | High             | • Safety a big issue; must not hinder ability to train or fight |

Source: BCG interviews, BCG analysis

"A malaria vaccine needs to be very effective for troops in the field" - KOL

"It needs to be highly effective for 4-6 months at least" - WRAIR

"Price/cost of the vaccine is not an important issue" - WRAIR

"A large section would have to be inoculated...this is unlikely to be cost effective" - Indian army

"Safety is a huge issue" - WRAIR
KEY TAKEAWAYS
Military Market

Preparedness is essential to maintaining an alert force
  • Malaria incidence is problematic for militaries
    - largely due to low chemoprophylaxis compliance from extended deployments

Vaccine used regularly as preventative tool

Demand will hinge on vaccine characteristics
  • Safety is key
    - troops must be able to train and fight without side effects or risks
  • Militaries will immunize segments of personnel based on vaccine profile
    - All troops vs. troops deploying to high-risk areas
  • Efficacy against clinical disease is critical
    - militaries cannot afford illness; “a sick soldier is a useless soldier”
    - vaccine must compete with prophylaxis compliance levels (50-80%)
  • Cost not an issue for militaries with high expenditures (i.e. US, UK, Japan), but may significantly affect demand from militaries with smaller budgets
TABLE OF CONTENTS

Project overview

Endemic country findings
  • Malaria burden
  • Public market
  • Private market

Travelers and military findings

Demand model methodology

Predicted vaccine market size

Implications and next steps

Appendix
MALARIA VACCINE DEMAND MODEL NEEDS TO BE FLEXIBLE AND TRANSPARENT DESPITE INHERENT COMPLEXITY

Key model attributes

- **Realistic**
  - Base demand estimate logic on well-established and reliable data and reasonable assumptions

- **Transparent**
  - Build user-friendly, logical model without a “black box” component

- **Flexible**
  - Allow MVI to improve quality of estimates through future research and model adaptation

- **Concrete**
  - Generate actual demand forecast ranges and sensitivities that are as accurate as possible given current data availability
MODEL FOLLOWS THE DEMAND LEAKAGE FRAMEWORK FOR ASSESSING MARKET POTENTIAL

A Need  B Product  C Access  D Attitude

Public:
Which countries?

Private:
Which individuals?

Travelers:
Which travelers?

Military:
Which militaries?

How does product profile influence?

Target population coverage / donor funding available?

Vaccinate none versus high risk versus infants versus children versus all?

How many doses of vaccine in a given year does this translate into?

How does product profile influence?

Private clinics/ability to pay?

Use private market for vaccine?

How does product profile influence?

Individuals seek pre-travel advice?

Prefer nothing versus chemoprophylaxis or vaccines?

How does product profile influence?

Military budget sufficient?

Vaccinate none versus all versus deployed only?
DEMAND MODEL USES SCENARIO DRIVERS, DATA INPUTS, AND ATTITUDINAL ALGORITHMS TO FORECAST DEMAND
Sample Information Flow – Does Not Represent Full Scope of Model

**Scenario drivers**
- Efficacy
- Duration
- Cost
- Funding

**Model logic**

<table>
<thead>
<tr>
<th>Data inputs</th>
<th>Attitudinal inputs</th>
<th>Attitudinal algorithms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, birth cohort</td>
<td>Include country X if efficacy &gt; Y</td>
<td>Include military if duration &gt; Z</td>
</tr>
<tr>
<td>GDP, income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaria incidence</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Modular outputs**

- Demand over time
  - 2010
  - 2011
  - 2025
- Demand by geography
  - Africa
  - SE Asia
  - S America
- Demand by population
  - Traveler
  - Public
  - Private
  - Military

"Model has flexibility to accommodate changes in vaccine landscape and country characteristics over time."
## INPUTS AND ALGORITHMS BASED ON FINDINGS FROM PRIMARY AND SECONDARY RESEARCH
Including Extensive Interviews In Eight Endemic Countries

### Data inputs based on primary and secondary sources

Secondary data from sources such as:
- WHO/RBM
- World Bank
- UN
- Global Fund
- OECD
- Journal of Travel Medicine
- US Department of Defense

Primary data from interviews
- Data sourced from reports and books published by in-country interviewees

### Attitudinal inputs incorporate learnings from country research

Sample algorithms include:
- Product profile threshold to introduce vaccine
- Use of vaccine vs. other components of intervention portfolio
- Attitude of government and donors with respect to demographic and regional targeting of vaccine
- Funding scenarios for the vaccine
- Military criteria for vaccinating all troops vs. deployed troops only
- Travelers choice of chemo-prophylaxis or vaccine

---

**Complete list of sources included in appendix**
PRIMARY RESEARCH FINDINGS WERE EXTRAPOLATED TO ALL ENDEMIC COUNTRIES VIA CLUSTERING METHODOLOGY

Clustering methodology

Country segmentation and selection for research

- Universe of malaria afflicted countries
  - Based on need and access/attitude

Country mapping

- Countries selected for research
  - Based on similarity of malaria related characteristics
  - Single research country data can be extrapolated to cluster

- Other countries
  - Combination of research country data can be extrapolated to cluster

Application in model

Model minimizes the need to cluster to increase accuracy
- Majority of model inputs are objective and specific to countries
- Few inputs based on cluster extrapolation

Country specific inputs include:
- Population size
- GDP/income data
- Health care infrastructure
- Access and coverage data

Cluster specific inputs include:
- Product profile levels at which vaccine likely to be accepted
- Attitude of governments with respect to segment of population covered (e.g., infants vs. high risk areas)
- Segments likely to have access to private market
FOUR KEY MODULES IN THE MODEL PROJECT DEMAND FOR PUBLIC, PRIVATE, MILITARY AND TRAVELERS MARKETS
DETAILED INFORMATION FLOW OF PUBLIC MARKET MODULE

Legend:
- Scenario drivers – for given product profile, e.g., Effic., Durn., Cost
- Data input from secondary sources
- Attitudinal inputs from primary research
- Algorithm applied this step
- Result of formula

World population ➔ Public market ➔ Area of country at risk ➔ Population distribution: Birth cohort, children < 5, pregnant women, etc. ➔ Medical coverage of target population (e.g., projected EPI) ➔ Acceptance of vaccine based on profile

Groups likely vaccinated for select countries ➔ Pop. likely vaccinated overall ➔ Rate of increase of new vaccine (based on analogs)

GoB funds available for malaria, cost-effectiveness ➔ Donor funds available for malaria, cost-effectiveness ➔ Number vaccinated

Dosage schedule and boosters required ➔ Compliance factor ➔ Number of doses

Population distribution: Birth cohort, children < 5, pregnant women, etc.
METHODOLOGY TO GENERATE UPTAKE SCENARIOS FOR EACH COUNTRY

- For each country individually
- Based on historic EPI data
  - for different vaccine coverage, e.g. DPT3 as base-line coverage, HepB as high coverage where implemented, others
- Based on progress in economic and health care indicators
- Using regression analysis, e.g. EPI coverage as influenced by GDP/cap
- Using specific scenarios
- Based on historic EPI data
- Baseline defined as uptake of DPT3 average for region
- Based on vaccine analogues
  - e.g. baseline: DPT3 average for region, fast: HepB average where implemented
- Based on scenarios around funding availability, sustainability planning, etc.

Define upper threshold for coverage
Run scenarios around upper threshold
Define rate of uptake
Run scenarios around uptake

Define rate of uptake

Run scenarios around uptake

E.g. ~ 80% in Ghana

Sc. 1: 70%

Sc. 2: 90%

Base-line uptake based on historic DPT3

DPT3
### INPUTS TO MODEL

<table>
<thead>
<tr>
<th>Scenario drivers</th>
<th>Data inputs (i)</th>
<th>Data inputs (ii)</th>
<th>Attitudinal algorithms</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Efficacy against clinical and severe disease</td>
<td>• Population by country</td>
<td>• Active military troops per country</td>
<td>• Product profile required for entry in public market</td>
</tr>
<tr>
<td>• Duration of action</td>
<td>• Population at risk</td>
<td>• % deployed to malaria-endemic regions</td>
<td>• Government view of which populations to vaccinate</td>
</tr>
<tr>
<td>• Cost per dose</td>
<td>• Projected birth cohort</td>
<td>• Deployment length</td>
<td>- Age-groups</td>
</tr>
<tr>
<td>• Doses required</td>
<td>• Projected children &lt; 5</td>
<td>• Average annual turnover</td>
<td>- Regions / states</td>
</tr>
<tr>
<td>• Boosters required</td>
<td>• Historical vaccine uptake by country per vaccine</td>
<td>• Budget per soldier</td>
<td>• Product profile required in private market</td>
</tr>
<tr>
<td>• Plasmodium target</td>
<td>• Projected EPI coverage</td>
<td>• Travelers to developed world from developing</td>
<td>• Attitude toward vaccination in private market</td>
</tr>
<tr>
<td>- P. falciparum</td>
<td>• Projected peak coverage and rate of increase of coverage for vaccines</td>
<td>• Percent who seek pre-travel advice</td>
<td>• Product profile required in military market</td>
</tr>
<tr>
<td>- P. vivax</td>
<td>• Compliance estimates</td>
<td>• Advance window for seeking advice</td>
<td>• MILITARIES’ likelihood to vaccinate troops</td>
</tr>
<tr>
<td>• Population</td>
<td>• GNI, per capita and household income distributions</td>
<td>• Percent who take chemo-prophylaxis</td>
<td>• Product profile required in travelers market</td>
</tr>
<tr>
<td>- Infants</td>
<td>• Physicians / capita</td>
<td>• Length of trip</td>
<td>• Fraction of travelers likely to get vaccine</td>
</tr>
<tr>
<td>- Children &lt; 5</td>
<td>• Urban vs. rural</td>
<td>• Product uptake curves in private, military and travelers markets</td>
<td></td>
</tr>
</tbody>
</table>
MODEL ALLOWS US TO RUN SCENARIOS AND SENSITIVITIES AROUND PREDICTED DEMAND
Also Creates Flexible Tool That Can Be Updated Over Time

A flexible and adaptable tool

Model uses base case to incorporate primary research findings and predict demand
• Inputs are variable and inter-relationships have been built across variables

Therefore, can develop and test complex scenarios around:
• Product profile
• Country-specific inputs
• Attitudes
• Other

Can also conduct sensitivity analyses around any single variable by changing it incrementally vs. other variables
SUMMARY OF MODEL METHODOLOGY

Model needs to be flexible and transparent despite inherent complexity
  • Needs to be realistic, transparent, flexible and concrete

Model follows the demand leakage framework for assessing market potential
  • Need, Product, Access and Attitude

Demand model uses scenario drivers, data inputs, and attitudinal algorithms to forecast demand

Inputs and algorithms based on findings from primary and secondary research
  • Including extensive interviews in eight endemic countries

Primary research was used to understand impact of demand drivers related to attitudes of key stakeholders where secondary data was unavailable
  • Findings from primary research extrapolated to all endemic countries via clustering methodology

Four key modules in the model project demand for public, private, military and travelers markets

Model allows us to run scenarios and calculate sensitivities around predicted demand
  • Creates flexible tool that can be updated over time
# TABLE OF CONTENTS

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  - Malaria burden
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- Travelers and military findings
- Demand model methodology
- Predicted vaccine market size
  - Public market
  - Private market
  - Travelers market
  - Military market
- Implications and next steps
- Appendix
PUBLIC MARKET DEMAND SCENARIOS

<table>
<thead>
<tr>
<th>Base Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
</tr>
<tr>
<td>Efficacy</td>
</tr>
<tr>
<td>Time of Introduction</td>
</tr>
<tr>
<td>Market Uptake</td>
</tr>
<tr>
<td>Cost</td>
</tr>
</tbody>
</table>
BASE CASE DEFINITIONS FOR THE PUBLIC MARKET

**Base case definition**

**Product profile of vaccine**
- Strain of vaccine: Falciparum
- Efficacy of vaccine: 50% against clinical and 50% against severe disease
- Age-groups: Protection at all age-groups except in pregnancy
- Duration of action: > 1 year
- Dosage: Three doses followed by annual booster
- Cost: US$ 7 / dose and US$ 5 incremental delivery cost per course; similar pricing in all malaria afflicted countries

**Funding availability**
- Donor organizations support malaria programs at current level, ~ US$ 300 Mn / year
- Funding of vaccine based on cost-effectiveness trade-offs with existing interventions
  - 30% of malaria dedicated funds used to provide vaccines
  - 10% of immunization funds used to provide a malaria vaccine
- Future growth of funds at donor country GDP growth
- Priority given to countries with highest need

**Timing of introduction**
- Vaccine registered for children < 5 years in 2010, for children > 5 in 2011 and in adults in 2012
- Post-licensure lag 5 years in Africa, 3 – 4 years ROW

**Uptake in markets**
- Maximum coverage based on EPI performance on DPT projected into the future
- Change in coverage based on past experience with new vaccine introduction

Source: BCG analysis
70685-02-DC Meeting-Handout-19Jan05-BW-BOS.ppt
PUBLIC MARKET FOR A MALARIA VACCINE
IN 2025 LIKELY TO BE ~70 MM PEOPLE
For a 50% Efficacious Vaccine, Unconstrained by Funding

Estimated vaccine demand with no funding constraints (2010-2025)

Key messages

Due to post-licensure introduction lag, uptake only begins 5 years after vaccine approval

Majority of demand from Africa due to lower efficacy levels of vaccine

Demand estimate assumes sufficient funding is available to fund all doses that can be delivered

Source: BCG analysis

The Boston Consulting Group
LEADING TO A MARKET SIZE IN 2025 OF 114 MM DOSES
For a 50% Efficacious Vaccine, Unconstrained by Funding

Estimated vaccine demand with no funding constraints - Doses (2010-2025)

Key messages
Conversion of number of vaccinated people to doses depends on
• Age profile of populations
• Boosters required by vaccine
• Compliance rate

Source: BCG analysis
HOWEVER, ONLY 35% OF FULL POTENTIAL DEMAND IS LIKELY TO BE FUNDED AT CURRENT DONOR ACTIVITY LEVELS

Comparison between full potential demand and funds likely to be available (2025)

Donor activity at the current level insufficient to fund full potential demand, 47 MM additional people could be protected with full funding

Note: Assuming current levels of donor activity in the future
Source: BCG analysis
FUNDING GAP INCREASES OVER TIME FROM 1 MM PEOPLE IN 2019 TO 47 MM PEOPLE IN 2025

Vaccine demand likely to be funded at current donor activity levels (2010-2025)

Key messages

- Countries unable to fully self-fund demand
  - As majority of demand for a 50% efficacious vaccine is from high burden, low income countries

- Donor activity at current levels insufficient to vaccinate all people who could be reached

- Gap increases over time as potential coverage increases faster than ability to fund a vaccine

Note: Assuming current levels of donor activity in the future
Source: BCG analysis

70685-02-DC Meeting-Handout-19Jan05-BW-BOS.ppt
PUBLIC MARKET DEMAND SCENARIOS

Base Case

Sensitivity

Efficacy

Time of Introduction

Market Uptake

Cost
DEMAND FOR A MALARIA VACCINE MOST SENSITIVE TO EFFICACY AND UPTAKE SCENARIOS
For Demand Unconstrained By Funding Availability

Sensitivity of funding unconstrained demand to model inputs (MM of people IN 2025)

<table>
<thead>
<tr>
<th>Model Input</th>
<th>Optimistic: % Clinical</th>
<th>Base Case: % Clinical</th>
<th>Pessimistic: % Clinical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>80%-clinical, 80%-severe</td>
<td>50%-clinical, 50%-severe</td>
<td>30%-clinical, 50%-severe</td>
</tr>
<tr>
<td>Uptake scenario</td>
<td>Optimistic: based on Hep B</td>
<td>Base Case: based on DPT-3</td>
<td>Pessimistic: based on slow analogues</td>
</tr>
<tr>
<td>Post-licensure lag</td>
<td>Optimistic: 3 yr lag in Africa, 1--2 in ROW</td>
<td>Base Case: 5 yr lag in Africa, 3–4 in ROW</td>
<td>Pessimistic: 7 yr lag in Africa, 5–6 in ROW</td>
</tr>
<tr>
<td>Use in pregnancy</td>
<td>Optimistic: Suitable, approved in 2012</td>
<td>Base Case: Not suitable</td>
<td>Pessimistic: N/A</td>
</tr>
</tbody>
</table>

% change:

- Optimistic: +117%
- Base Case: -39%
- Pessimistic: -65%

Note: Sensitivity to demand drivers keeping all other variables constant at base-case levels; ROW: Rest Of the World
Source: BCG analysis

THE BOSTON CONSULTING GROUP
DEMAND FOR A MALARIA VACCINE MOST SENSITIVE TO COST AND FUNDING GROWTH
At Current Funding Levels

Sensitivity of funded demand for 2025 to model inputs (MM of people)

<table>
<thead>
<tr>
<th>Input</th>
<th>Optimistic</th>
<th>Base Case</th>
<th>Pessimistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine cost</td>
<td>$4 / dose</td>
<td>$7 / dose</td>
<td>$10 / dose</td>
</tr>
<tr>
<td>Funding Growth</td>
<td>doubles GDP growth</td>
<td>matches GDP growth</td>
<td>halves GDP growth</td>
</tr>
<tr>
<td>Vaccine funding</td>
<td>15% of funds</td>
<td>10% of funds</td>
<td>5% of funds</td>
</tr>
<tr>
<td>Malaria funding</td>
<td>35% of funds</td>
<td>30% of funds</td>
<td>25% of funds</td>
</tr>
<tr>
<td>Delivery cost</td>
<td>$4 / dose</td>
<td>$5 / dose</td>
<td>$6 / dose</td>
</tr>
</tbody>
</table>

Note: Sensitivity to demand drivers keeping all other variables constant at base-case levels
Source: BCG analysis
PUBLIC MARKET DEMAND SCENARIOS

Base Case

Sensitivity

Efficacy

Time of Introduction

Market Uptake

Cost
DEMAND FOR AN 80% EFFICACIOUS VACCINE AS HIGH AS 154 MM PEOPLE IN 2025 WITH UNCONSTRAINED FUNDING

Funding unconstrained demand for varying vaccine efficacy levels (2025)

**Efficacy profile**

- **80% clinical, 80% severe**
  - Africa: 71 MM
  - S & SEA: 71 MM
  - Americas: 43 MM
  - Eastern Europe: 43 MM
  - Total: 154 MM

**Key messages**

Efficacy has a significant impact on vaccine demand
- Funding unconstrained demand for highest efficacy vaccine considered is 300% that of the lowest efficacy vaccine considered
- 60% of demand for a 50% efficacious vaccine from Africa
  - However, at 80% efficacy significant uptake (63% of demand) outside of Africa

Uptake driven by a combination of factors
- Efficacy thresholds at which vaccine is accepted in a country
  - e.g., uptake in Thailand requires 80% efficacy
- Attitude of governments with respect to population segments targeted, both demographic and geographic
- Ability of country to reach target population

Source: BCG analysis

70685-02-DC Meeting-Handout-19Jan05-BW-BOS.ppt
76% OF DEMAND FOR AN 80% EFFICACIOUS VACCINE LIKELY TO BE FUNDED IN 2025 AT CURRENT DONOR ACTIVITY LEVELS

Key messages

Portion of donor and country funds committed to a malaria vaccine increases at higher efficacy levels
- 50% of donor and country malaria funds dedicated to a vaccine at 80% efficacy
- 30% of donor and country malaria funds dedicated to a vaccine at 50% efficacy

Higher efficacy results in a higher proportion of full potential demand being funded
- 76% of funding unconstrained demand fulfilled for 80% efficacy vaccine
- 34% for a 50% efficacy vaccine

Countries contribute towards a larger proportion of funding at higher efficacy levels
- As richer countries, with lower malaria, burden are willing to take up vaccine
- However, ability of poorer countries to fund vaccine is limited

Source: BCG analysis

THE BOSTON CONSULTING GROUP
DEMAND FOR 80% EFFICACIOUS VACCINE IN ANY GIVEN YEAR
MORE THAN TWICE THAT FOR A 50% EFFICACIOUS VACCINE

Source: BCG analysis
PUBLIC MARKET DEMAND SCENARIOS

Base Case

Sensitivity

Efficacy

Time of Introduction

Market Uptake

Cost
REDDUCING THE POST-LICENSESURE LAG BY 2 YEARS COULD LEAD TO 60 MM MORE PEOPLE BEING VACCINATED FOR AN 80% Efficacious Vaccine

Source: BCG analysis
## PUBLIC MARKET DEMAND SCENARIOS

<table>
<thead>
<tr>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
</tr>
<tr>
<td>Sensitivity</td>
</tr>
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</tr>
<tr>
<td>Time of Introduction</td>
</tr>
<tr>
<td>Market Uptake</td>
</tr>
<tr>
<td>Cost</td>
</tr>
</tbody>
</table>
ADVOCACY AND IMPLEMENTATION SUPPORT FROM DONORS COULD LEAD TO 140 MM MORE PEOPLE VACCINATED IN 2025

Demand for an 80% efficacious vaccine unconstrained by funding - People (2010-2025)

Demand at current funding levels for an 80% efficacious vaccine – People (2010-2025)

Note: Assuming current levels of donor activity in the future
Source: BCG analysis
PUBLIC MARKET DEMAND SCENARIOS

Base Case

Sensitivity

Efficacy

Time of Introduction

Market Uptake

Cost
FOR A US$ 2 / DOSE VACCINE, ALL OF DEMAND COULD BE FUNDED AT CURRENT DONOR ACTIVITY LEVELS

Key messages

Countries and donors would consider adding a malaria vaccine to existing portfolio of interventions

Cost-effectiveness of the vaccine in comparison to existing interventions affects:
  • Willingness to fund vaccine
  • Proportion of funds allocated to vaccine

Proportion of funds committed to a malaria vaccine increases at lower cost levels

Results in a higher proportion of full potential demand being fulfilled at lower cost, assuming current funding levels
  • 100% of potential demand fulfilled for a US$ 2 / dose vaccine
  • Only 5% of potential demand fulfilled for a US$ 20 / dose vaccine

Note: All cost scenarios assume similar incremental vaccine delivery cost of US$ 5 / course, all US$ values refer to 2003 US$
Source: BCG Analysis
US$ 7 VACCINE CAN BE FULLY FUNDED TILL 2019, US$ 2 VACCINE CAN BE FULLY FUNDED THROUGHOUT At Current Funding Levels

Note: All cost scenarios assume similar incremental vaccine delivery cost of US$ 5 / course, all US$ values refer to 2003 US$ 
Source: BCG Analysis

70685-02-DC Meeting-Handout-19Jan05-BW-BOS.ppt
# SUMMARY OF PUBLIC MARKET DEMAND

<table>
<thead>
<tr>
<th>Base Case</th>
<th>70 MM people could receive a 50% efficacious vaccine priced at US$ 7 / dose in 2025 if sufficient funding is available</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- However, only 35% of full potential demand is likely to be funded at current donor activity levels</td>
</tr>
<tr>
<td></td>
<td>- Number of people unable to be vaccinated at current donor activity levels increases from 1 MM people in 2019 to 47 MM people in 2025</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Efficacy</th>
<th>Demand for an 80% efficacious vaccine as high as 154 MM people in 2025 with unconstrained funding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- 76% of demand for an 80% efficacious vaccine likely to be funded in 2025</td>
</tr>
<tr>
<td></td>
<td>- Demand for 80% efficacious vaccine in any given year more than twice that for a 50% efficacious vaccine</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time of introduction</th>
<th>Reducing the time lag between approval of vaccine and implementation in country by 2 years could lead to 60 MM more people being vaccinated, for an 80% efficacious vaccine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Advocacy and implementation support from donors could lead to 140 MM more people vaccinated in 2025</td>
</tr>
<tr>
<td></td>
<td>- By affecting fundamental access issues and improving government’s ability to deliver vaccines</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Market uptake</th>
<th>With a low cost vaccine, full potential demand for a 50% efficacious vaccine could be fulfilled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>- US$ 7 vaccine can be fully funded till 2019, US$ 2 vaccine can be fully funded throughout</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost</th>
<th>Demand estimates most sensitive to efficacy, cost, funding growth and market uptake rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>

---

Demand estimates most sensitive to efficacy, cost, funding growth and market uptake rates.
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Appendix
## PRIVATE MARKET DEMAND SCENARIOS

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Base Case</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Efficacy</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Time of Introduction</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Affordability</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td></td>
</tr>
</tbody>
</table>
BASE CASE DEFINITIONS FOR THE PRIVATE MARKET

Base case definition

**Product profile of vaccine**
- Strain of vaccine: Falciparum
- Efficacy of vaccine: 50% against clinical and 50% against severe disease
- Age-groups: Protection at all age-groups except in pregnancy
- Duration of action: > 1 year
- Dosage: Three doses followed by annual booster
- Cost: US$ 15 / dose and US$ 5 delivery cost per course; similar pricing in all malaria afflicted countries

**Vaccine affordability**
- Families are willing to spend upto 2 weeks of annual household income to vaccinate household members

**Timing of introduction**
- Vaccine registered for children < 5 years in 2010, for children > 5 in 2011 and in adults in 2012
- Post-licensure lag 2 years in Africa, 1 – 2 years ROW

Source: BCG analysis
1.4 MM PEOPLE LIKELY TO BUY A 50% EFFICACIOUS VACCINE, 70% FROM AFRICA

Estimated vaccine demand by geography - People (2010-2025)

Key messages

Post-licensure lag may be shorter in private market

• As Govt. vaccine adoption and funding constraints typically delay public market uptake

Majority of demand from Africa due to lower efficacy levels of vaccine

Source: BCG analysis
LEADING TO A MARKET SIZE IN 2025 OF 2.2 MM DOSES
For a 50% Efficacious Vaccine, Costing US$ 15 / dose

Estimated vaccine demand by geography - Doses (2010-2025)

Key messages
Conversion of number of vaccinated people to doses depends on
- Age profile of populations
- Boosters required by vaccine
- Compliance rate

Source: BCG analysis
PRIVATE MARKET DEMAND SCENARIOS

Base Case

Sensitivity

Efficacy

Time of Introduction

Affordability

Cost
PRIVATE MARKET DEMAND FOR A MALARIA VACCINE
MOST SENSITIVE TO EFFICACY

Sensitivity of private market demand for 2025 to model inputs (MM of people)

<table>
<thead>
<tr>
<th>Input</th>
<th>Optimistic</th>
<th>Base Case</th>
<th>Pessimistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficacy</td>
<td>80%-clinical, 80%-severe</td>
<td>50%-clinical, 50%-severe</td>
<td>30%-clinical, 50%-severe</td>
</tr>
<tr>
<td></td>
<td>+1150%</td>
<td>-100%</td>
<td>-25%</td>
</tr>
<tr>
<td>Delivery cost</td>
<td>3 weeks annual income</td>
<td>2 weeks annual income</td>
<td>1 week annual income</td>
</tr>
<tr>
<td></td>
<td>+36%</td>
<td>-25%</td>
<td>-14%</td>
</tr>
<tr>
<td>Vaccine cost</td>
<td>$10 / dose</td>
<td>$15 / dose</td>
<td>$20 / dose</td>
</tr>
<tr>
<td></td>
<td>+21%</td>
<td>-14%</td>
<td>-14%</td>
</tr>
<tr>
<td>Affordability</td>
<td>1 week annual income</td>
<td>$20 / dose</td>
<td></td>
</tr>
<tr>
<td></td>
<td>+2%</td>
<td>-14%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimistic: $4 / dose</td>
<td>Base Case: $5 / dose</td>
<td>Pessimistic: $16 / dose</td>
</tr>
</tbody>
</table>

# of people (MM in 2025)

Source: BCG analysis
<table>
<thead>
<tr>
<th>Private Market Demand Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
</tr>
<tr>
<td>Sensitivity</td>
</tr>
<tr>
<td>Efficacy</td>
</tr>
<tr>
<td>Time of Introduction</td>
</tr>
<tr>
<td>Affordability</td>
</tr>
<tr>
<td>Cost</td>
</tr>
</tbody>
</table>
DEMAND FOR AN 80% EFFICACIOUS VACCINE AS HIGH AS 17 MM PEOPLE IN 2025

Private market demand for varying vaccine efficacy levels (2025)

<table>
<thead>
<tr>
<th>Efficacy profile</th>
<th># of people (MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>80% clinical, 80% severe</td>
<td>17.4</td>
</tr>
<tr>
<td>50% clinical, 50% severe</td>
<td>1.4</td>
</tr>
<tr>
<td>30% clinical, 50% severe</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: BCG analysis

Key messages

Efficacy has a significant impact on vaccine demand
- Demand for 80% efficacious vaccine is more than 10 times that for a 50% efficacious vaccine

Uptake driven by a combination of factors
- Efficacy thresholds at which vaccine is accepted in a country
  - e.g., uptake in Thailand requires 80% efficacy
- Affordability of vaccine to country populations based on projected income distributions
- Population size of countries

Majority of demand for 80% efficacious vaccine from outside Africa
PRIVATE MARKET DEMAND SCENARIOS

Base Case

Sensitivity

Efficacy

Time of Introduction

Affordability

Cost
EARLY APPROVAL AND INTRODUCTION COULD INCREASE DEMAND BY 3.9 MM PEOPLE BETWEEN ’10 AND ’25

Private market demand for a 50% efficacious vaccine - People (2010-2025)

Incremental demand due to early introduction

# of people (MM)

Source: BCG analysis
PRIVATE MARKET DEMAND SCENARIOS

Base Case

Sensitivity

Efficacy

Time of Introduction

Affordability

Cost
AS FEW AS 0.7 MN PEOPLE MAY BUY VACCINE IF THEY ARE WILLING TO SPEND 1% OF ANNUAL INCOME
For A 50% Efficacious Vaccine

Private market demand at varying affordability levels for a 50% efficacious vaccine - People (2010-2025)

Source: BCG analysis
PRIVATE MARKET DEMAND SCENARIOS

Base Case

Sensitivity

Efficacy

Time of Introduction

Affordability

Cost
DEMAND RANGES BETWEEN 1.7 MM TO 1.0 MM PEOPLE FOR A PRICE RANGE OF US$ 10 TO 30 PER DOSE

Funded demand for varying cost levels of a 50% efficacious vaccine (2025)

Key messages

Private market demand driven by two sub-segments of the high income population in countries
- A very high income group which is relatively price insensitive
- A relatively lower income group with sufficient discretionary income to afford a vaccine, but which is sensitive to price

Results in relatively low price sensitivity when compared to the public market

Majority of demand for a 50% efficacious vaccine comes from Africa across cost levels

Note: All cost scenarios assume similar incremental vaccine delivery cost of US$ 5 / course, all US$ values refer to 2003 US$
Source: BCG Analysis
SUMMARY OF PRIVATE MARKET DEMAND

1.4 MM people likely to buy a 50% efficacious vaccine, 70% from Africa
   • Uptake likely to begin 3 years after approval
   • Limited uptake from regions outside Africa where higher efficacy needed

Demand for an 80% efficacious vaccine as high as 17 MM people in 2025
   • Efficacy has a significant impact on vaccine demand
   • Demand for 80% efficacious vaccine is more than 10 times that for a 50% efficacious vaccine
   • Majority of demand for 80% efficacious vaccine from outside Africa
   • Uptake driven by a combination of factors
     - Efficacy thresholds at which vaccine is accepted in a country
     - e.g., uptake in Thailand requires 80% efficacy
     - Affordability of vaccine to country populations based on projected income distributions

Early approval and introduction of vaccine, within 1 year of vaccine approval, could increase demand by 3.9 MM people between 2010 and 2025

0.7 MM people may buy vaccine if they are willing to spend 1% of annual income, as compared to 1.4 MM people if they are willing to spend 2 weeks of annual income

Demand ranges between 1.7 MM to 1.0 MM people for a price range of US$ 10 to 30 per dose, as compared to 1.4 MM people for a US$ 15 per dose vaccine
   • Private market demand driven by two sub-segments of the high income population in countries
     - A very high income group which is relatively price insensitive
     - A relatively lower income group with sufficient discretionary income to afford a vaccine, but which is sensitive to price

Demand estimates most sensitive to efficacy
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TRAVELERS MARKET LIKELY TO RANGE BETWEEN 1.7 AND 3.3 MM PEOPLE IN 2025

Demand ranges from 1.7 MM to 3.3 MM people in 2025

Demand sensitivity highest to time in-country required to generate interest in vaccine

Peak demand likely to be in the range of 1.7 and 3.3 MM people in 2025
- However close to 100% efficacious vaccine required
- Sensitive to in-country stay assumptions, cost and administration schedule

Note: Assuming one arrival per traveler per country per year
Source: BCG analysis
60% OF DEMAND IN TRAVELERS MARKET LIKELY TO BE FROM EUROPEAN TRAVELERS Driven By Higher Rate Of Prophylaxis Use

Estimated vaccine demand by origin of traveler’s - People (2010-2025)

- Base Case
  Demand based on travelers who take prophylaxis for malaria and stay longer than 4 weeks in country

- Demand based on travelers who plan 4-8 weeks in advance and stay > 4 weeks

Note: Assuming one arrival per traveler per country per year
Source: BCG analysis

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- 112 -
DEMAND FOR A VACCINE IN THE RANGE OF 1.2 MM IF 10% ARE FREQUENT TRAVELERS WITH 3 ARRIVALS / YEAR

Base Case
Demand based on travelers who take prophylaxis for malaria and stay longer than 4 weeks in country
100% of travelers arrive once / year / country

Demand based on travelers who take prophylaxis for malaria and stay longer than 4 weeks in country
90% of travelers arrive once / year / country, 10% of travelers arrive 3 times / year / country

Source: BCG analysis
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  • Public market
  • Private market
  • Travelers market
    • Military market

Implications and next steps

Appendix
### PEAK ANNUAL DEMAND FOR A MALARIA VACCINE IN THE MILITARY RANGES FROM 0-13 MM THROUGH 2025

**2025 Scenarios**

<table>
<thead>
<tr>
<th>Efficacy Against Clinical Disease</th>
<th>&gt; 80%</th>
<th>50- 80%</th>
<th>&lt; 50%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Vaccine Cost</td>
<td>12.5MM</td>
<td>0.8MM</td>
<td>0</td>
</tr>
<tr>
<td>$&lt;$20</td>
<td>2.9MM</td>
<td>0.8MM</td>
<td>0</td>
</tr>
<tr>
<td>$20-100$</td>
<td>2.5MM</td>
<td>0.3MM</td>
<td>0</td>
</tr>
<tr>
<td>$&gt;$100</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Significant impact of efficacy on demand**

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Cost</th>
<th>Efficacy</th>
<th># of people (MM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-endemic country militaries</td>
<td>High</td>
<td>&gt; 80%</td>
<td>6.1</td>
</tr>
<tr>
<td>Endemic country militaries</td>
<td>Low</td>
<td>&lt; 50%</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>50- 80%</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>&gt; 80%</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Med</td>
<td>50- 80%</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>&lt; 50%</td>
<td>12.5</td>
</tr>
</tbody>
</table>

**Key:**
- Cost: Low - $< 20, Med - $20 – 100, High - $> 100
- Efficacy: Low - < 50%, Med – 50 – 80%, High - > 80%

**Military demand sensitive to efficacy and cost**

Source: BCG analysis
EFFICACY OF VACCINE HAS SIGNIFICANT IMPACT ON MARKET
12.5 MM People Likely to Receive a 80% Efficacious Vaccine

Source: BCG analysis
70685-02-DC Meeting-Handout-19Jan05-BW-BOS.ppt

Vaccine efficacy:
50% against clinical and 50% against severe disease

Vaccine efficacy:
80% against clinical and 80% against severe disease
DEMAND FOR A US$ 50 / DOSE VACCINE LIKELY TO BE RESTRICTED TO NON-ENDEMIC COUNTRY MILITARIES

Estimated military market demand for a US$ 50/ dose vaccine - People (2010-2025)

Vaccine efficacy:
50% against clinical and 50% against severe disease

Estimated military market demand for a US$ 50/ dose vaccine - People (2010-2025)

Vaccine efficacy:
80% against clinical and 80% against severe disease

Source: BCG analysis
70685-02-DC Meeting-Handout-19Jan05-BW-BOS.ppt
SUMMARY OF TRAVELERS AND MILITARY MARKET DEMAND

Travelers market likely to range between 1.7 and 3.3 MM people in 2025
  • However efficacy needs to be close to 100%, similar to existing chemoprophylaxis
  • Only travelers who stay longer than 2 - 4 weeks and who plan at least 4 weeks in advance likely to consider a vaccine
  • Demand is sensitive to assumptions around average number of trips per person per year

60% of demand in travelers market likely to be from European travelers

Military market likely to be in the range of 0.7 MM people in 2025 for a 50% efficacious vaccine costing US$ 15 / dose
  • Demand likely only from non-endemic country militaries at 50% efficacy levels
  • Demand for a US$ 50 / dose vaccine likely to be restricted to non-endemic country militaries

Higher efficacy of vaccine has significant impact on military market
  • 12.5 MM people likely to receive a 80% efficacious vaccine at US$ 15 / dose as compared to only 0.7 MM people for a 50% efficacious vaccine

Cost of vaccine impacts demand for the vaccine, especially from armies with relatively lower health care budgets
  • Number of people receiving an 80% efficacious vaccine would reduce from 12.5 MM to 2.8 MM people (in 2025) if cost of vaccine was US$ 50 / dose instead of US$ 15 / dose
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BASE CASE DEVELOPED USING BEST CURRENT KNOWLEDGE
Can Become More Specific As Vaccine Candidates Progress Toward Licensure

Model structure has been developed to allow it to be an adaptable, living tool
  • Inputs and assumptions can be dynamically changed

Assumptions for data and attitudes will continue to be refined as new information is obtained over time

As we learn more about the emerging product profile of a specific vaccine candidate, we will be able to more accurately predict expected demand

Although we cannot pinpoint a single specific demand “answer”, there are common themes that we believe will continue to most heavily drive demand over time
FOUR CENTRAL THEMES EMERGED ACROSS MARKETS

Substantial need/potential demand exists across all four markets examined

Specific requirements for product profile exist and vary significantly by country
  • Efficacy thresholds
  • Minimum duration to be considered
  • Species of malaria

Ease of access will drive uptake, especially EPI program suitability

Third parties play an influential role
  • Donor community
  • Local and global scientific communities
### Key Findings by Market

**Given Development Timelines, Important to Focus On Developing Desired Product Profile And Influencing Public Market Attitudes**

<table>
<thead>
<tr>
<th>Need</th>
<th>Product</th>
<th>Access</th>
<th>Attitude</th>
</tr>
</thead>
</table>
| • Burden high throughout Africa, in border areas elsewhere | • There is role for partial efficacy  
- W Africa 50% vs. E Africa 80%  
- Duration > 1 yr  
- Cost critical | • Desire for administration through EPI program | • Use of portfolio approach to fight malaria  
- WHO support  
- Donor funding  
- Need for local clinical data |
| • Burden high throughout Africa, in border areas elsewhere | • Efficacy of 50% due to alternatives  
- Duration > 1 yr | • Limited by individual income, access to clinics | • Willingness to pay for private health services |
| • Travelers to malaria endemic regions increasing | • Must have efficacy greater than or equal to prophylaxis | • Relevant for travelers who seek pre-travel advice | • Will likely prefer vaccine over prophylaxis for longer trips |
| • Low prophylaxis compliance and desire for readiness gives high need | • Mission comes first, need high clinical efficacy  
- No side effects  
- Min duration 4-6 mo | • Reach during basic training or before deployment | • Vaccinate if helps mission |

**Public Market**
- Burden high throughout Africa, in border areas elsewhere

**Private Market**
- Burden high throughout Africa, in border areas elsewhere

**Travelers**
- Travelers to malaria endemic regions increasing

**Military**
- Low prophylaxis compliance and desire for readiness gives high need
THREE FACTORS MOST INFLUENCE FUTURE SUCCESS OF MALARIA VACCINE

Product profile

Product profile has the strongest influence on demand, as the vaccine must reach stated thresholds to have any uptake
  • Efficacy and cost are key drivers, demand in the public market expected to be:
    - 71 MM people with clinical and severe efficacy of 50%, growing to 154 MM at ~80%
    - 50 MM additional people could be funded if cost of vaccine was lowered from $7 to $2 per dose
  • P. falciparum component and one year duration are important minimum requirements

Funding

Donor funding can drive demand by stimulating early markets and enabling less wealthy countries’ purchase and administration of vaccine
  • Public markets will rely heavily on sustainable funding to introduce vaccine
    - uptake only 7 MM people in base case scenario without donor funding
  • With strong donor advocacy and implementation support, demand in the public market could reach 290 MM people with clinical and severe efficacy of 80%
  • Private markets likely to lag public markets since they do not “turn on” until higher efficacy level reached
    - unlikely to be achieved in first generation vaccine

Influencer support

Support of WHO, academics, and standards-setting organizations are key to vaccine’s introduction and credibility
  • Support of key third-party organizations can influence lag between licensure and introduction
  • Countries and donors both both rely on key opinion leaders and WHO recommendations in deciding on which interventions to support
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**Appendix**

- Detailed description of demand model
- Primary research sources
- Secondary research sources
- Contact information
MODEL FOLLOWS THE DEMAND LEAKAGE FRAMEWORK FOR ASSESSING MARKET POTENTIAL

A Need

B Product

C Access

D Attitude

Public: A1 Which countries?

B1 How does product profile influence?

C1 Target population coverage / donor funding available?

D1 Vaccinate none versus high risk versus infants versus children versus all?

E How many doses of vaccine in a given year does this translate into?

Private: A2 Which individuals?

B2 How does product profile influence?

C2 Private clinics/ ability to pay?

D2 Use private market for vaccine?

Travelers A3 Which travelers?

B3 How does product profile influence?

C3 Individuals seek pre-travel advice?

D3 Prefer nothing versus chemoprophylaxis or vaccines?

Military: A4 Which militaries?

B4 How does product profile influence?

C4 Military budget sufficient?

D4 Vaccinate none versus all versus deployed only?
**QUESTION A1 WHAT COUNTRIES ACROSS THE WORLD NEED A MALARIA VACCINE?**

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>Population</th>
<th>Birth cohort (Es)</th>
<th>Population &lt; 5 (Est)</th>
<th>GDP CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>America Andean</td>
<td>Bolivia</td>
<td>8,586,443</td>
<td>214,661</td>
<td>1,073,305</td>
<td>2,370</td>
</tr>
<tr>
<td></td>
<td>Colombia</td>
<td>41,662,073</td>
<td>1,041,552</td>
<td>5,207,759</td>
<td>6,519</td>
</tr>
<tr>
<td></td>
<td>Ecuador</td>
<td>13,710,234</td>
<td>342,756</td>
<td>1,713,779</td>
<td>3,905</td>
</tr>
<tr>
<td></td>
<td>Peru</td>
<td>28,409,897</td>
<td>710,247</td>
<td>3,551,237</td>
<td>4,888</td>
</tr>
<tr>
<td></td>
<td>Venezuela</td>
<td>24,654,694</td>
<td>616,367</td>
<td>3,081,837</td>
<td>6,402</td>
</tr>
<tr>
<td>America Brazil</td>
<td>Brazil</td>
<td>182,032,604</td>
<td>4,550,815</td>
<td>22,754,076</td>
<td>7,537</td>
</tr>
<tr>
<td></td>
<td>Mexico</td>
<td>103,718,062</td>
<td>2,592,952</td>
<td>12,964,758</td>
<td>8,903</td>
</tr>
<tr>
<td>Americas</td>
<td>Belize</td>
<td>266,440</td>
<td>6,661</td>
<td>33,305</td>
<td>5,351</td>
</tr>
<tr>
<td></td>
<td>Guyana</td>
<td>702,100</td>
<td>17,553</td>
<td>87,763</td>
<td>4,046</td>
</tr>
<tr>
<td></td>
<td>Suriname</td>
<td>435,449</td>
<td>10,886</td>
<td>54,431</td>
<td>4,217</td>
</tr>
<tr>
<td>Central Africa</td>
<td>Cameroon</td>
<td>15,746,179</td>
<td>393,654</td>
<td>1,968,272</td>
<td>1,269</td>
</tr>
<tr>
<td></td>
<td>Central African Republic</td>
<td>3,683,538</td>
<td>92,088</td>
<td>460,442</td>
<td>1,289</td>
</tr>
<tr>
<td></td>
<td>Chad</td>
<td>9,253,493</td>
<td>231,337</td>
<td>1,156,667</td>
<td>656</td>
</tr>
<tr>
<td>Central Africa</td>
<td>Congo</td>
<td>2,954,258</td>
<td>73,856</td>
<td>369,282</td>
<td>1,036</td>
</tr>
<tr>
<td></td>
<td>Equatorial Guinea</td>
<td>510,473</td>
<td>12,762</td>
<td>63,809</td>
<td>5,239</td>
</tr>
<tr>
<td></td>
<td>Gabon</td>
<td>1,321,560</td>
<td>33,039</td>
<td>165,195</td>
<td>5,514</td>
</tr>
<tr>
<td>Central Africa</td>
<td>Sao Tome and Principe</td>
<td>175,883</td>
<td>4,397</td>
<td>21,985</td>
<td>954</td>
</tr>
<tr>
<td>Central America</td>
<td>Costa Rica</td>
<td>3,896,092</td>
<td>97,402</td>
<td>487,012</td>
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<td>1,415,626</td>
<td>7,078,130</td>
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<td>3,854,886</td>
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<td>Afghanistan</td>
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<td>3,589,652</td>
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</tr>
</tbody>
</table>

- Model contains a master country data sheet
- Lists all countries in the world
- Selects those that are endemic to malaria
- Contains detailed data on
  - Economic profile and development
  - Population profile and growth
  - Malaria related statistics
  - Health care statistics

All information on this sheet is based on data and fixed with respect to the model.
**QUESTION B1: HOW DOES POTENTIAL PRODUCT PROFILE DRIVE DEMAND? (I)**

- Sheet captures a matrix that defines a product profile
- All parameters on the matrix are variable, allowing demand to be estimated for a wide range of profiles
- Matrix captures the interplay between:
  - Efficacy
  - Duration of action
  - Target population
  - Clinical manifestation
  - Dosage
  - Schedule
  - Cost of vaccine

<table>
<thead>
<tr>
<th>Species of malaria</th>
<th>Disease target</th>
<th>Age-group</th>
<th>Duration of action</th>
</tr>
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<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 6 months</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 months to &lt; 1 year</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 year</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 1 to 5 years</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 5 years</td>
<td>50%</td>
</tr>
</tbody>
</table>

- **Dosage chart**
  - Dosage: Initial dosage = 3
  - Gap between doses 0 & 1 (months): 1
  - Gap between doses 1 & 2 (months): 1
  - Gap between doses 2 & 3 (months): 1
  - Gap between doses 3 & 4 (months): 1
  - Gap between doses 4 & 5 (months): 1
  - Frequency of booster doses (once every _ months): 12
  - Applicable during pregnancy: Yes

- **Cost of vaccine**
  - Cost per dose in public market (US$): Cost A = 2, Cost B = 10, Cost C = 20
  - # doses in initial administration: 3
  - Need for annual booster: Yes

**Note:** All inputs on this sheet are variables.
**QUESTION B2 HOW DOES POTENTIAL PRODUCT PROFILE DRIVE DEMAND? (II)**

<table>
<thead>
<tr>
<th>Cluster Id</th>
<th>Country / Cluster</th>
<th>Product profile parameter</th>
<th>Minimum required to enter market type</th>
<th>Result for market type</th>
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<tbody>
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<td></td>
<td></td>
<td></td>
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<td>Private market</td>
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<tr>
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<td>50%</td>
</tr>
<tr>
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<td>Ghana cluster</td>
<td>Duration of activity</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>1</td>
<td>Ghana cluster</td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>1</td>
<td>Africa cluster 1</td>
<td>Cost of vaccine</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Nigeria cluster</td>
<td>Efficacy / effect</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td>2</td>
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<td>Duration of activity</td>
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<tr>
<td>2</td>
<td>Nigeria cluster</td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>3</td>
<td>Senegal cluster</td>
<td>Efficacy / effect</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td>3</td>
<td>Senegal cluster</td>
<td>Duration of activity</td>
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</tr>
<tr>
<td>4</td>
<td>Brazil cluster</td>
<td>Efficacy / effect</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>4</td>
<td>Brazil cluster</td>
<td>Duration of activity</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Brazil cluster</td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>5</td>
<td>Tanzania cluster</td>
<td>Efficacy / effect</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>5</td>
<td>Tanzania cluster</td>
<td>Duration of activity</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>Tanzania cluster</td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>6</td>
<td>Mozambique cluster</td>
<td>Efficacy / effect</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
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<td>Mozambique cluster</td>
<td>Duration of activity</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>6</td>
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<tr>
<td>7</td>
<td>India cluster</td>
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<td>Duration of activity</td>
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<tr>
<td>7</td>
<td>India cluster</td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>8</td>
<td>Thailand cluster</td>
<td>Efficacy / effect</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td>8</td>
<td>Thailand cluster</td>
<td>Duration of activity</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>Thailand cluster</td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>

- Product profile – Entry sheet captures research findings on minimum threshold required to enter market
- Establishes whether vaccine will enter market based on assumed product profile
- Captures information at the level of clusters

**All inputs on this sheet are variables**
**QUESTION (B2) HOW DOES POTENTIAL PRODUCT PROFILE DRIVE DEMAND? (III)**

<table>
<thead>
<tr>
<th>Cluster Id</th>
<th>Country / Cluster</th>
<th>% of population that will be considered</th>
<th>Donor funding availability (1 = Government to self-fund, 2 = Full availability of funds from donors, 3 = Partial funding available from donors)</th>
<th>% of total health expenditure likely to be spent on malaria</th>
<th>% of malaria spend likely on vaccine</th>
<th>Intent to vaccinate children &lt; 1</th>
<th>Intent to vaccinate pregnant women</th>
<th>Intent to vaccinate children 1-5</th>
<th>Intent to vaccinate children &gt; 5</th>
<th>Intent to vaccinate adults</th>
<th>Annual Compliance rate to boosters</th>
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</thead>
<tbody>
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<td>100%</td>
<td>1</td>
<td>30%</td>
<td>30%</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>70%</td>
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<tr>
<td>2</td>
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<td>100%</td>
<td>1</td>
<td>30%</td>
<td>30%</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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</tr>
<tr>
<td>3</td>
<td>Senegal cluster</td>
<td>100%</td>
<td>1</td>
<td>30%</td>
<td>30%</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>80%</td>
</tr>
<tr>
<td>4</td>
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<td>1</td>
<td>10%</td>
<td>30%</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>30%</td>
<td>30%</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
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</tr>
<tr>
<td>7</td>
<td>India cluster</td>
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<td>1</td>
<td>15%</td>
<td>30%</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>80%</td>
</tr>
<tr>
<td>8</td>
<td>Thailand cluster</td>
<td>5%</td>
<td>1</td>
<td>10%</td>
<td>30%</td>
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<td>Yes</td>
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<td>9</td>
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<td>Yes</td>
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<td>10%</td>
<td>30%</td>
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<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
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<tr>
<td>12</td>
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<td>30%</td>
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<td>Yes</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>No</td>
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<td>10%</td>
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<td>10%</td>
<td>30%</td>
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<td>15%</td>
<td>30%</td>
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<td>Yes</td>
<td>No</td>
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<td>Yes</td>
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<tr>
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<td>No</td>
</tr>
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<td>20</td>
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<td>30%</td>
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<td>21</td>
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<td>30%</td>
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<td>Yes</td>
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<td>No</td>
</tr>
<tr>
<td>22</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

- Clustering methodology used to extrapolate in-country research findings, especially attitudinal parameters, to the malaria afflicted countries around the world
- Methodology based on malaria burden and country income levels

**Public market**

All inputs on this sheet are variables
QUESTION (B2) HOW DOES POTENTIAL PRODUCT PROFILE DRIVE DEMAND? (IV)

- Methodology based on malaria burden and country income levels
- Findings form in-country research segmented on the basis of above parameters
- Findings extrapolated to non-research countries

All inputs on this sheet are variables
QUESTION C1 IN THE PUBLIC MARKET, WHAT PROPORTION OF POPULATION IS LIKELY TO HAVE ACCESS TO THE VACCINE?

- For each country individually
- Based on historic EPI data
  - for different vaccine coverage, e.g. DPT3 as base-line coverage, HepB as high coverage where implemented, others
- Based on progress in economic and health care indicators
- Using regression analysis, e.g. EPI coverage as influenced by GDP/cap
- Using specific scenarios
- Based on historic EPI data
- Based on vaccine analogues
  - e.g. baseline: DPT3 average for region, fast: HepB average where implemented
- Based on scenarios around funding availability, sustainability planning, etc.
QUESTION D1: BASED ON ATTITUDE OF GOVERNMENTS, WHAT PROPORTION OF POPULATION WILL BE TARGETED?

- **Regional profile:** Population that will be considered by government to be targets for the vaccine
  - E.g. Africa countries 100%, Brazil 10%, Thailand 5%
- **Demographic profile:** Age-groups and demographic profiles considered by the government for public market
  - E.g. Africa: <5s and pregnant women, Thailand all age-groups

<table>
<thead>
<tr>
<th>Cluster Id</th>
<th>Country / Cluster</th>
<th>% of population that will be considered</th>
<th>Intent to vaccinate children &lt; 1</th>
<th>Intent to vaccinate pregnant women</th>
<th>Intent to vaccinate children 1-5</th>
<th>Intent to vaccinate children &gt; 5</th>
<th>Intent to vaccinate adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ghana cluster</td>
<td>100%</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
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<td>2</td>
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<td>100%</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Senegal cluster</td>
<td>100%</td>
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<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Brazil cluster</td>
<td>10%</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>100%</td>
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<td>Yes</td>
<td>No</td>
<td>No</td>
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<td>6</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
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<td>15%</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
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</tr>
<tr>
<td>8</td>
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<td>5%</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

All inputs on this sheet are variables.
**QUESTION D1**

**BASED ON ATTITUDE OF GOVERNMENTS AND DONORS, WHAT PROPORTION OF FUNDING WILL BE AVAILABLE FOR A MALARIA VACCINE?**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cost of vaccine compared to ITNs</th>
<th>Notes</th>
<th>Efficacy of vaccines compared to ITNs</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vhigh</td>
<td>20 More than 2X ITN cost</td>
<td>90% &gt; 90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>15 More than 1.5X ITN cost</td>
<td>60% &gt; 2X ITNs</td>
<td></td>
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</tr>
<tr>
<td>Medium</td>
<td>Within 50% of ITN cost</td>
<td>Less than 2X ITNs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>7.5 Less than 50% of ITN cost</td>
<td>Less than ITNs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Cost-effectiveness in comparison with other interventions used to estimate proportion of donor and country funding that could be dedicated to a malaria vaccine**

**Based on interview findings donor organizations and country Ministries of Finance**

<table>
<thead>
<tr>
<th>Parameter (Cost)</th>
<th>Parameter (Efficacy)</th>
<th>Concatenate</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Low Low</td>
<td>LowLowLow</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Medium Low MediumLow</td>
<td>MediumMedium</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>High Low HighLow</td>
<td>HighLow</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Low Medium LowMedium</td>
<td>LowMedium</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>Medium Medium MediumMedium</td>
<td>MediumMedium</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>High Medium HighMedium</td>
<td>HighMedium</td>
<td>20%</td>
<td></td>
</tr>
<tr>
<td>Vhigh Medium VhighMedium</td>
<td>MediumVhigh</td>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>Low Medium Medium</td>
<td>MediumHigh</td>
<td>60%</td>
<td></td>
</tr>
<tr>
<td>High Medium MediumHigh</td>
<td>HighMedium</td>
<td>50%</td>
<td></td>
</tr>
<tr>
<td>High High HighHigh</td>
<td>HighHigh</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>Vhigh Medium LowVhigh</td>
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<td></td>
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<tr>
<td>Low Medium Medium</td>
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<td>80%</td>
<td></td>
</tr>
<tr>
<td>Medium Vhigh VhighVhigh</td>
<td>VhighVhigh</td>
<td>80%</td>
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</tr>
<tr>
<td>High Vhigh VhighVhigh</td>
<td>VhighVhigh</td>
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<tr>
<td>Vhigh Vhigh VhighVhigh</td>
<td>VhighHigh</td>
<td>60%</td>
<td></td>
</tr>
</tbody>
</table>

**Product profile**

<table>
<thead>
<tr>
<th>Efficacy lookup</th>
<th>Cost lookup</th>
</tr>
</thead>
<tbody>
<tr>
<td>50.0%</td>
<td>8.67</td>
</tr>
</tbody>
</table>

**Donor /Country funding factor**

<table>
<thead>
<tr>
<th>Cost result</th>
<th>Efficacy result</th>
<th>Concatenate result</th>
<th>Funding result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>MediumMedium</td>
<td>MediumMedium</td>
<td>30%</td>
</tr>
</tbody>
</table>
**QUESTION B1: HOW MANY DOSES OF VACCINE IN A GIVEN YEAR DOES THIS TRANSLATE INTO?**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Year A</th>
<th>Year B</th>
<th>Year C</th>
<th>Year D</th>
<th>Year E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth cohort &amp; pregnant women</td>
<td>(A_1 \times N_i)</td>
<td>(B_1 \times N_i)</td>
<td>(C_1 \times N_i)</td>
<td>(D_1 \times N_i)</td>
<td>(E_1 \times N_i)</td>
</tr>
<tr>
<td>Children aged 1 – 5 years</td>
<td>(\sum A_{2.5} \times N_i)</td>
<td>(\sum A_{2.5} \times N_{IB} \times (B_{2.5} - A_{2.5}) \times N_i \times CF_1)</td>
<td>(\sum A_{2.5} \times N_{IB} \times (B_{2.5} - A_{2.5}) \times N_i \times CF_2)</td>
<td>(\sum A_{2.5} \times N_{IB} \times (B_{2.5} - A_{2.5}) \times N_i \times CF_3)</td>
<td>(\sum A_{2.5} \times N_{IB} \times (B_{2.5} - A_{2.5}) \times N_i \times CF_4)</td>
</tr>
<tr>
<td>Children &gt; 5 and adults</td>
<td>(\sum A_{2.5} \times N_i)</td>
<td>(\sum A_{2.5} \times N_{IB} \times (B_{2.5} - A_{2.5}) \times N_i \times CF_1)</td>
<td>(\sum A_{2.5} \times N_{IB} \times (B_{2.5} - A_{2.5}) \times N_i \times CF_2)</td>
<td>(\sum A_{2.5} \times N_{IB} \times (B_{2.5} - A_{2.5}) \times N_i \times CF_3)</td>
<td>(\sum A_{2.5} \times N_{IB} \times (B_{2.5} - A_{2.5}) \times N_i \times CF_4)</td>
</tr>
</tbody>
</table>

Same as children 1 – 5, except progression does not stop after 5th year.

Compliance factor, number of initial and booster doses are variables.

- \(A_i\) = Population of age \(i\) in year \(A\)
- \(CF_n\) = Compliance factor for cluster / country for \(n^{th}\) year
- \(N_i\) = Number of initial doses
- \(N_{IB}\) = Number of booster doses / year
**QUESTION A2 WHAT COUNTRIES ACROSS THE WORLD NEED A MALARIA VACCINE?**

- Model contains a master country data sheet
- Lists all countries in the world
- Selects those that are endemic to malaria
- Contains detailed data on:
  - Economic profile and development
  - Population profile and growth
  - Malaria related statistics
  - Health care statistics

<table>
<thead>
<tr>
<th>Region</th>
<th>Country</th>
<th>MALARIA</th>
<th>Population</th>
<th>Birth cohort (Es)</th>
<th>Population &lt; 5 (Est)</th>
<th>GDP CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>America Andean</td>
<td>Bolivia</td>
<td>1</td>
<td>8,586,443</td>
<td>214,661</td>
<td>1,073,305</td>
<td>2,370</td>
</tr>
<tr>
<td>America Andean</td>
<td>Colombia</td>
<td>1</td>
<td>41,662,073</td>
<td>1,041,552</td>
<td>5,207,759</td>
<td>6,519</td>
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<tr>
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<td>Ecuador</td>
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<td>13,710,234</td>
<td>342,756</td>
<td>1,713,779</td>
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<tr>
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<td>28,409,897</td>
<td>710,247</td>
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<td>4,888</td>
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<td>24,654,694</td>
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<td>3,081,837</td>
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<tr>
<td>America Brazil</td>
<td>Brazil</td>
<td>1</td>
<td>182,032,604</td>
<td>4,550,815</td>
<td>22,754,076</td>
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<td>Mexico</td>
<td>1</td>
<td>103,718,062</td>
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<tr>
<td>Americas</td>
<td>Belize</td>
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<td>266,440</td>
<td>6,661</td>
<td>33,305</td>
<td>5,351</td>
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<td>Guyana</td>
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<td>702,100</td>
<td>17,553</td>
<td>87,763</td>
<td>4,046</td>
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<td>54,431</td>
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<td>393,654</td>
<td>1,968,272</td>
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<td>Central African Republic</td>
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<td>92,088</td>
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<td>231,337</td>
<td>1,156,687</td>
<td>666</td>
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<td>Equatorial Guinea</td>
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<td>12,762</td>
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<td>5,239</td>
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<td>833,724</td>
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<td>128,213</td>
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<td>Democratic Republic of t</td>
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<td>1,415,626</td>
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<td>152,404</td>
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<td>Ethiopia</td>
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<td>1,663,939</td>
<td>8,319,694</td>
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<td>Kenya</td>
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<td>790,707</td>
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<tr>
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<td>Rwanda</td>
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<td>195,251</td>
<td>976,257</td>
<td>796</td>
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<td>Afghanistan</td>
<td>1</td>
<td>28,717,213</td>
<td>717,930</td>
<td>3,589,652</td>
<td>609</td>
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<tr>
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<td>Djibouti</td>
<td>1</td>
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<td>57,141</td>
<td>1,288</td>
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<td>9,330,850</td>
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<td>Iran (Islamic Republic o</td>
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</table>

All information on this sheet is based on data and fixed with respect to the model.
### QUESTION B2: HOW DOES POTENTIAL PRODUCT PROFILE DRIVE DEMAND? (II)

<table>
<thead>
<tr>
<th>Cluster Id</th>
<th>Country / Cluster</th>
<th>Product profile parameter</th>
<th>Minimum required to enter market type</th>
<th>Result for market type</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Public market</td>
<td>Private market</td>
</tr>
<tr>
<td>1</td>
<td>Ghana cluster</td>
<td>Efficacy / effect</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration of act</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>2</td>
<td>Nigeria cluster</td>
<td>Efficacy / effect</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration of act</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>3</td>
<td>Senegal cluster</td>
<td>Efficacy / effect</td>
<td>30%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration of act</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>Brazil cluster</td>
<td>Efficacy / effect</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration of act</td>
<td>12</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>5</td>
<td>Tanzania cluster</td>
<td>Efficacy / effect</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
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<td>Duration of act</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>6</td>
<td>Mozambique cluster</td>
<td>Efficacy / effect</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration of act</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>7</td>
<td>India cluster</td>
<td>Efficacy / effect</td>
<td>80%</td>
<td>80%</td>
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<td></td>
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<td>Duration of act</td>
<td>12</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
<tr>
<td>8</td>
<td>Thailand cluster</td>
<td>Efficacy / effect</td>
<td>80%</td>
<td>80%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duration of act</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Age-group</td>
<td>All</td>
<td>All</td>
</tr>
</tbody>
</table>

- Product profile – Entry sheet captures research findings on minimum threshold required to enter market
- Establishes whether vaccine will enter market based on assumed product profile
- Captures information at the level of clusters

All inputs on this sheet are variables
QUESTION C2 IN THE PRIVATE MARKET, WHAT PROPORTION IS LIKELY TO BE ABLE TO AFFORD THE VACCINE? (I)

- Define per capita income and growth
- Develop income distribution pyramids
- Determine affordability levels
- Estimate population sizes with income levels

For each country individually
Determine per capita income and growth rates

For geographic regions
- E.g. Sub-Saharan Africa, East Africa, etc.

Based on interview findings
Determine affordability levels
- What % of per capita income likely to be spent on malaria vaccine
- E.g. 2 weeks income, 1% of annual income, etc.

Develop scenarios for various cost levels of the vaccine

COUNTRY_NAME | Growth rate | 2003 GNI
---|---|---
Albania | 15.7% | 1740
Algeria | 5.3% | 1890
Angola | 14.5% | 740
Antigua and Barbuda | 2.4% | 9160
Armenia | 10.8% | 950
Australia | 0.9% | 21650
Austria | 0.6% | 26720
Azerbaijan | 9.2% | 810
Bahamas, The | 1.6% | 15110
Kingdom of Bahrain | 3.7% | 11260
Bangladesh | 2.0% | 400
Barbados | 1.7% | 9270
Belarus | 3.0% | 1590
Belgium | 0.7% | 25820
Belize | 1.9% | 3190
Benin | 3.1% | 440
Bhutan | 8.9% | 660
Bolivia | -2.6% | 890
Bosnia and Herzegovina | 5.6% | 1540
Botswana | 3.3% | 3430
Brazil | -8.7% | 2710

Income levels and growth are fixed, income pyramids and affordability inputs are variables.
QUESTION C2 IN THE PRIVATE MARKET, WHAT PROPORTION IS LIKELY TO BE ABLE TO AFFORD THE VACCINE? (II)

Affordability model for private sector uses multiple regression equations

3rd degree polynomial regression equation used to model affordability till 3 X of average income

Linear equations used to model affordability > 3 X of average income
QUESTION D2

BASED ON ATTITUDES IN PRIVATE MARKET, WHAT PROPORTION OF POPULATION WILL BE TARGETED? (II)

- Population likely to need vaccine given distribution of malaria and attitudes
- Given coverage by public market, portion that will procure vaccine in private market
  - Adjustments made for high-income families who prefer private vaccination
- Portion of population with access to private vaccination

<table>
<thead>
<tr>
<th>Cluster Id</th>
<th>Country / Cluster</th>
<th>% of population that will be interested</th>
<th>Uptake likely from private market for children &lt; 1</th>
<th>Uptake likely from private market for pregnant women</th>
<th>Uptake likely from private market for children 1 - 5</th>
<th>Uptake likely from private market for children &gt; 5</th>
<th>Uptake likely from private market for adults</th>
</tr>
</thead>
<tbody>
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<td>Ghana cluster</td>
<td>100%</td>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>2</td>
<td>Nigeria cluster</td>
<td>100%</td>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>Senegal cluster</td>
<td>100%</td>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>4</td>
<td>Brazil cluster</td>
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<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Tanzania cluster</td>
<td>100%</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Mozambique cluster</td>
<td>100%</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>India cluster</td>
<td>100%</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>8</td>
<td>Thailand cluster</td>
<td>5%</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

All inputs on this sheet are variables.
**QUESTION E2: HOW MANY DOSES OF VACCINE IN A GIVEN YEAR DOES THIS TRANSLATE INTO?**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Year A</th>
<th>Year B</th>
<th>Year C</th>
<th>Year D</th>
<th>Year E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birth cohort &amp; pregnant women</td>
<td>$A_1 \times N_i$</td>
<td>$B_1 \times N_i$</td>
<td>$C_1 \times N_i$</td>
<td>$D_1 \times N_i$</td>
<td>$E_1 \times N_i$</td>
</tr>
<tr>
<td>Children aged 1 – 5 years</td>
<td>$\sum A_{2-5} \times N_i$</td>
<td>$\sum A_{2-5} \times N_{IB} \times CF_1$</td>
<td>$\sum (B_{2-5} - A_{2-5}) \times \frac{N_{IB}}{N_i} \times CF_1$</td>
<td>$\sum (B_{2-5} - A_{2-5}) \times \frac{N_{IB}}{N_i} \times CF_2$</td>
<td>$\sum (B_{2-5} - A_{2-5}) \times \frac{N_{IB}}{N_i} \times CF_3$</td>
</tr>
<tr>
<td>Children &gt; 5 and adults</td>
<td>$\sum (C_{2-5} - B_{2-5}) \times \frac{N_{IB}}{N_i} \times CF_1$</td>
<td>$\sum (C_{2-5} - B_{2-5}) \times \frac{N_{IB}}{N_i} \times CF_2$</td>
<td>$\sum (C_{2-5} - B_{2-5}) \times \frac{N_{IB}}{N_i} \times CF_3$</td>
<td>$\sum (D_{2-5} - C_{2-5}) \times \frac{N_{IB}}{N_i} \times CF_1$</td>
<td>$\sum (E_{2-5} - D_{2-5}) \times \frac{N_{IB}}{N_i}$</td>
</tr>
</tbody>
</table>

Same as children 1 – 5, except progression does not stop after 5th year

Compliance factor, number of initial and booster doses are variables. CF separate for public and private markets

$A_i =$ Population of age $i$ in year A  
$CF_n =$ Compliance factor for cluster / country for $n^{th}$ year  
$N_i =$ Number of initial doses  
$N_{IB} =$ Number of booster doses / year
**METHODOLOGY AND ASSUMPTIONS FOR TRAVELERS MARKET**

**A3**
Traveler market need determined by WTO international tourism statistics from the developed world to malaria endemic regions as defined by the WHO

- To determine the number of travelers at risk for malaria, countries were clustered depending on rate of traveler mobility to high-risk malaria regions (rural areas, jungle/bush, provinces with high indices of malaria)

**B3**
Model assumes minimum product profile requirements/thresholds for vaccine adoption

- Assumptions include: efficacy requirement of 98%, 5 week malarone cost of $200, and a vaccine that requires three doses

**C3**
Pre-travel medical advice and prophylaxis use drawn from traveler behaviour studies from the Journal of Travel Medicine

**D3**
For purpose of scenarios travelers were grouped by planning and duration habits

- Travelers who take prophylaxis
- Projected uptake based on current Hep A immunization rates
- Travelers who take prophylaxis and stay in destination for over 2 weeks
- Travelers who plan 4-8 weeks in advance and stay in destination for over 4 weeks
- Travelers who take prophylaxis and stay in destination for over 4 weeks

**D3**
Uptake of vaccine assumed to be similar to private market uptake curve
## TRAVELER MARKET TRIANGULATION

### Hep A Proxy

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travelers from developed world to high-risk areas</td>
<td>22 M</td>
</tr>
<tr>
<td>in malaria endemic countries</td>
<td></td>
</tr>
<tr>
<td>% of American travelers that get Hep A vaccine</td>
<td>14%</td>
</tr>
<tr>
<td>% of European travelers that get Hep A vaccine</td>
<td>37%</td>
</tr>
<tr>
<td>% of Asian travelers that get Hep A vaccine</td>
<td>5%</td>
</tr>
<tr>
<td>Total travelers from developed world that got Hep A vaccine in 2002</td>
<td>4.5 M</td>
</tr>
</tbody>
</table>

### Malarone Sales

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total global prophylaxis sales in 2004</td>
<td>$290 M</td>
</tr>
<tr>
<td>Total global malarone sales in 2004</td>
<td>$78 M</td>
</tr>
<tr>
<td>Average duration of travel</td>
<td>18 Days</td>
</tr>
<tr>
<td>~ Cost of malarone per day</td>
<td>$5</td>
</tr>
<tr>
<td>Total number of travelers that took malarone in 2004</td>
<td>.9 M</td>
</tr>
</tbody>
</table>

(1) Travelers to areas where they are at risk of contracting Hep A, 'developed world' refers to travelers from Asia, Europe, and the Americas as defined by WTO
(2) Duration of travel based on Journal of Travel Medicine studies covering Asian, U.S. and European travelers
MILITARY NEED SEGMENTED INTO NUMBER OF TROOPS LIKELY TO RECEIVE VACCINATION

Militaries need vaccinations to maximise troop readiness and avoid illness

Three primary options for choosing a population to vaccinate:
1) All troops
2) No troops
3) Troops deployed to malaria-endemic regions

Snapshot: Deployment sizing in the model

<table>
<thead>
<tr>
<th>Sample: Countries without malaria: ~5% deployed</th>
<th>Sample: Countries w/ malaria: same % as pop. at risk are deployed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>Algeria</td>
</tr>
<tr>
<td>Canada</td>
<td>Cambodia</td>
</tr>
<tr>
<td>Japan</td>
<td>Djibouti</td>
</tr>
<tr>
<td>Poland</td>
<td>Ethiopia</td>
</tr>
<tr>
<td>UK</td>
<td>Malaysia</td>
</tr>
<tr>
<td>US</td>
<td>Saudi Arabia</td>
</tr>
</tbody>
</table>
VACCINE COST AND EFFICACY INFLUENCE MILITARY DEMAND, SAFETY AND DURATION ACT AS THRESHOLD CRITERIA

Vaccine efficacy and cost are key demand variables and were segmented into three tiers

<table>
<thead>
<tr>
<th>Vaccine Efficacy (Clinical)</th>
<th>Vaccine Cost (total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (&lt;50%)</td>
<td>Low (&lt; $20)</td>
</tr>
<tr>
<td>Medium (50-80%)</td>
<td>Medium ($20-$100)</td>
</tr>
<tr>
<td>High (&gt;80%)</td>
<td>High (&gt; $100)</td>
</tr>
</tbody>
</table>

Duration and safety are threshold criteria—militaries are unlikely to accept a vaccine that lasts <6 months or one with serious side-effects
MILITARY BUDGETS DRIVE ABILITY TO PAY FOR VACCINE

Military expenditure levels segmented into three tiers

\[\text{US} \quad \text{UK} \quad \text{Japan} \quad \text{Australia} \quad \text{Saudi Arabia} \quad \text{Canada} \quad \text{Netherlands} \quad \text{Sweden} \quad \text{France} \quad \text{Germany} \quad \text{Italy} \quad \text{Israel} \quad \text{Russia} \quad \text{UAE} \quad \text{Spain} \quad \text{Taiwan} \quad \text{Czech} \quad \text{Portugal} \quad \text{Greek} \quad \text{S. Korea} \quad \text{Croatia} \quad \text{Indonesia} \quad \text{Ukraine} \quad \text{Libya}\]

Snapshot: Top 25 spending / active member

\(\text{$Spent / Member (In thousands)$}\)

High budget

Medium budget

Low budget

US DOD spends ~$15-17B each year for the Defense Health Program, or ~$6,000/person

PEAK ANNUAL DEMAND FOR A MALARIA VACCINE IN THE MILITARY RANGES FROM 0-13 MM THROUGH 2025

### 2015 Scenarios

<table>
<thead>
<tr>
<th>Efficacy Against Clinical Disease &lt; 50%</th>
<th>&lt;$20</th>
<th>$20-$100</th>
<th>&gt;$100</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 80%</td>
<td>7.7MM</td>
<td>1.6MM</td>
<td>1.3MM</td>
</tr>
<tr>
<td>50-80%</td>
<td>0.5MM</td>
<td>0.5MM</td>
<td>0.2MM</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

### 2025 Scenarios

<table>
<thead>
<tr>
<th>Efficacy Against Clinical Disease &lt; 50%</th>
<th>&lt;$20</th>
<th>$20-$100</th>
<th>&gt;$100</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 80%</td>
<td>12.5MM</td>
<td>2.9MM</td>
<td>2.5MM</td>
</tr>
<tr>
<td>50-80%</td>
<td>0.8MM</td>
<td>0.8MM</td>
<td>0.3MM</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Significant impact of efficacy on demand

Military demand sensitive to efficacy and cost

Source: BCG analysis
ASSUMPTIONS: TIERING OF VACCINE EFFICACY AND COST, MILITARY BUDGETS AND DEPLOYMENT

Tiering of Scenarios

<table>
<thead>
<tr>
<th>Military Budget</th>
<th>Vaccine Efficacy (Clinical)</th>
<th>Vaccine Cost (total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (&lt;$50,000 / Active Member)</td>
<td>Low (&lt;50%)</td>
<td>Low (&lt; $20)</td>
</tr>
<tr>
<td>Medium (&gt;=$50,000 / Active Member)</td>
<td>Medium (50-80%)</td>
<td>Medium ($20-$100)</td>
</tr>
<tr>
<td>High (&gt;=$150,000 / Active Member)</td>
<td>High (&gt;80%)</td>
<td>High (&gt;$100)</td>
</tr>
</tbody>
</table>

Average Deployment Time: 120 days
% Newly Deployed in A Cycle: 40%

Scenario Uptake Levels

<table>
<thead>
<tr>
<th>Military Budget Segmentation</th>
<th>Vaccine Efficacy Segmentation</th>
<th>Vaccine Cost Segmentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Medium</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

Snapshot: Variables in military model

<table>
<thead>
<tr>
<th>Country</th>
<th>Budget Segmentation</th>
<th>Efficacy Segmentation</th>
<th>Price Segmentation</th>
<th>Malaria Risk (1-Yes, 0-No)</th>
<th>% Deployed</th>
<th>% Used (1-Deployed, 2-All, 0-None)</th>
<th>Potential New Vaccines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albania</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>0</td>
<td>5%</td>
<td>2</td>
<td>6,628</td>
</tr>
<tr>
<td>Algeria</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>1</td>
<td>100%</td>
<td>2</td>
<td>128,281</td>
</tr>
<tr>
<td>Argentina</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>1</td>
<td>10%</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Armenia</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>1</td>
<td>5%</td>
<td>2</td>
<td>5,222</td>
</tr>
<tr>
<td>Australia</td>
<td>Medium</td>
<td>High</td>
<td>Low</td>
<td>0</td>
<td>5%</td>
<td>1</td>
<td>53,795</td>
</tr>
<tr>
<td>Austria</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>0</td>
<td>5%</td>
<td>2</td>
<td>5,184</td>
</tr>
<tr>
<td>Azerbaijan</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
<td>1</td>
<td>5%</td>
<td>2</td>
<td>7,814</td>
</tr>
</tbody>
</table>
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  • Primary research sources
  • Secondary research sources
  • Contact information
BRAZIL INTERVIEWS

Amazon Tropical Medicine Foundation (5 people)
FIOCRUZ (4 people)
Ministry of Health (3 people)
Hospital das Clinicas/University of Sao Paulo (3 people)
INPE– National Institute of Space Research
World Bank
WHO/PAHO
USAID
GHANA INTERVIEWS

Ministry of Health (6 people)
Noguchi Memorial Institute (2 people)
GSK Ghana (2 people)
Food & Drugs Board
EPID Researcher
USAID
MEDEX
NPO-Malaria, WHO
Dodowa Health Research Institute
Malaria Consortium Office
National Malaria Control Office
Heath Research Unit, Ghana Health Service
National Malaria Control Programme
DFID
HACI-Ghana
Ghana Social Marketing Foundation
INDIA INTERVIEWS

GSK, India (3 people)
Ministry of Health (2 people)
NVBDCP (2 people)
Epidemic Diseases Hospital and MRC (2 people)
UNICEF
WHO India
WHO SEARO
ICGEB
Ex Director, NAMP
National Institute of Health and Family Welfare
Universal Program of Immunization
Sir Dorabji Tata Center for Research in Tropical Diseases
Manipal Hospital
Vidarbha Hospital
Sangeetha Nursing Home
MOZAMBIQUE INTERVIEWS

Ministry of Health (5 people)
World Vision (3 people)
UNICEF (2 people)
CISM (2 people)
Ministry of Planning and Finance (2 people)
National Malaria Control Programme
Universidade de Eduardo Mondlane
Health Alliance International
Malaria, PSI
DFID
Save the Children
USAID
Ilha de Josina Community
WHO Mozambique
WHO AFRO
Child Survival Program, World Relief
Government health official, Maputo Province
Project Hope
Bethesda Clinic (private), Maputo
World Bank, Mozambique
NIGERIA INTERVIEWS

NIPRD (8 people)
Isolo General Hospital (5 people)
FMOH (4 people)
Zankli Medical Center (3 people)
House of Representatives, Committee on Health (3 people)
Lagos State Ministry of Health (3 people)
NAFDAC (2 people)
Lowanson Community Partners for Health (2 people)
Federal Capital Territory, Dept. of Public Health
Health Department, Gwagwalada Local Government
Universal Gaskiya Pharmacy Ltd.
National Programme of Immunization
GSK, West & Central Africa
Gwagwalada Local Government
National Assembly Clinic
Nigerian Medical Association
NIMR
RBM, WHO
UNICEF
USAID
DFID
Hope for AIDS and Life Outreach
SENEGAL INTERVIEWS

Ministry of Health (3 people)
Bambey District Health Centre (2 people)
Fann Hospital (2 people)
PATH (2 people)
WHO (2 people)
BASICS
DERF
GSK
Hopital Aristide le Dantec Service au Pediatrie
UNICEF
USAID
World Vision
TANZANIA INTERVIEWS

Ministry of Health (8 people)
St. Francis Hospital, Ifakara (5 people)
World Health Organization (3 people)
USAID (2 people)
National Malaria Control Programme
National Institute for Medical Research
Ministry of Finance
Africa Region, World Bank
Muhimbili University School of Public Health
DFID
Tanzania FDA
African Malaria Network Trust
Ifakara Health Research & Development Centre, LSHTM
HealthScope Tanzania
Project Manager, Reproductive and Child Health, African Medical and Research
Ifakara Research and Development Centre
AAR (Tanzanian Health Insurance Provider/Private Clinic Operator)
THAILAND INTERVIEWS

Faculty of Tropical Medicine, Mahidol University (4 people)
MoPH (3 people)
Biogenetech Co. Ltd. (2 people)
Shoklo Malaria Unit, Mae Sod, Tak province
National Science and Technology Development Agency
Wellcome Trust Unit Bangkok
Department of Immunology & Medicine, AFRIMS
The Global Fund
Wellcome Trust Unit Bangkok
WHO SAE
Faculty of Tropical Medicine, Mahidol University
TRAVELER INTERVIEWS

Centers for Disease Control and Prevention (3 people)
Tropical & Geographic Medicine Ctr., Division of Infectious Diseases,
Massachusetts General Hospital
Infectious and Tropical Disease Dept., London School of Hygiene and Tropical Medicine

Center for Travel and Tropical Medicine, Toronto General Hospital
London School of Hygiene and Tropical Medicine
MILITARY INTERVIEWS

WRAIR (3 people)
Sir Dorabji Tata Center for Research in Tropical Diseases
Consultant Public Health Physician, British Forces
GSK, former WRAIR
DONOR AND POLICYMAKER INTERVIEWS

GSK (7 people)
PATH (5 people)
WHO (3 people)
CDC (3 people)
DFID (3 people)
RBM (2 people)
USAID (2 people)
World Bank (2 people)
UNICEF (2 people)
JICA
Netherlands Ministry
GAVI
Global Fund
WHO AFRO
Initiatives on PPP for Health
NIH
Ifakara
STI
MMV
MIM
## INTERVIEW TOPICS VARIED BY TARGET GROUP

<table>
<thead>
<tr>
<th>Target</th>
<th>Government Officials</th>
<th>Physicians/KOLs</th>
<th>Private market</th>
<th>Donors and policymakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topics</td>
<td>Overview of current malaria situation and approach to prevention and treatment</td>
<td>Overview of current malaria situation</td>
<td>Experience with malaria in household</td>
<td>Overview of current malaria situation</td>
</tr>
<tr>
<td></td>
<td>Current funding for malaria interventions</td>
<td>View of current malaria interventions and unmet needs</td>
<td>Impact of malaria on productivity and other metrics</td>
<td>Interventions that are funded/supported and rationale</td>
</tr>
<tr>
<td></td>
<td>Process/rationale for resource allocation</td>
<td>Methods by which patients access malaria care and treatment</td>
<td>Interventions currently used</td>
<td>Unmet needs</td>
</tr>
<tr>
<td></td>
<td>Unmet needs</td>
<td>Reactions to potential profile attributes and ranges</td>
<td>Amount of money currently spent on malaria interventions and other drugs/vaccines</td>
<td>Reactions to potential profile attributes and ranges</td>
</tr>
<tr>
<td></td>
<td>Reactions to potential product profile attributes and ranges</td>
<td>Assessment of private market</td>
<td>High-level reactions to potential product attributes</td>
<td>Assessment of private market</td>
</tr>
<tr>
<td></td>
<td>Assessment of private market</td>
<td>Key influencers that will impact demand</td>
<td>Key influencers and other factors that will impact demand</td>
<td>Key influencers and other factors that will impact demand</td>
</tr>
<tr>
<td></td>
<td>Key influencers and other factors that will impact demand</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
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SECONDARY SOURCES

Brazil Ministry of Health Datatsus
Case study on the costs and financing of immunization services in Ghana (Abt Associates)
Center for Disease Information, Bureau of Arms Control “World Military Expenditures and Arms Transfers”
CDC Malaria Surveillance Report 2002
Countrywatch
DASA
DFID “Developing a Sustainable ITN Market in Mozambique” RFP, May 2004
DHS (1997 data)
Food and Agriculture Organization of the United Nations (2002 data)
GAVI
Ghana EPI Financial Sustainability Plan (GAVI)
Ghana Health Report
Heritage
IMS (2003 data)
India Ministry of Health Datatsus
Institute of Medicine of Natural Sciences
Journal of Travel Medicine, “Travel Health Knowledge, Attitudes and Practices among US Travelers”
Journal of Travel Medicine, “Travelers Knowledge, Attitudes and Practices on Prevention of Infectious Diseases: Results from a Pilot Study”
Journal of Travel Medicine, “Travelers Knowledge, Attitudes and Practices on the Prevention of Infectious Diseases”
SECONDARY SOURCES

LSHTM
Malaria Foundation International
MICS data (1998-2001)
Mozambique Financial Stability Plan (GAVI)
National Malaria Control Program Health Facility and Community Survey 2004 (2003 data)
Naval Medical Research Institute
NIC (2000)
PAHO
Project Hope: A Study to Describe Barriers To Childhood Vaccination in Mozambique
Roll Back Malaria (Abuja criteria)
Survey of basic vaccine coverage in Thailand (2003)
Tanzania Ministry of Health
Thai Ministry of Public Health
The Global Fund
U.S. Department of Defense
UK Department of Trade and Investment
UNICEF
SECONDARY SOURCES

US Census Bureau
US Department of Defense, IIS “Military Balance”
USAID
Virtual Naval Hospital
WHOLIS
WHOSIS
World Bank
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CONTACT INFORMATION

MIV, PATH Central Number: 206-285-3500
Contact: Patricia Atkinson Roberts

BCG Central Number: 617-973-1200
Contacts: Wendy Woods, Dave Matheson