

MARKET ASSESSMENT FOR MALARIA VACCINES

February, 2005

THE BOSTON CONSULTING GROUP

AGENDA

Project overview

Research findings

- Endemic public market
- Endemic private market
- Travelers market
- Military market

Demand model methodology

Predicted vaccine market size

Key Findings

PROJECT OBJECTIVE: ASSESS MARKET FOR POTENTIAL MALARIA VACCINE AND DEVELOP MODEL TO ESTIMATE DEMAND

Situation and objectives

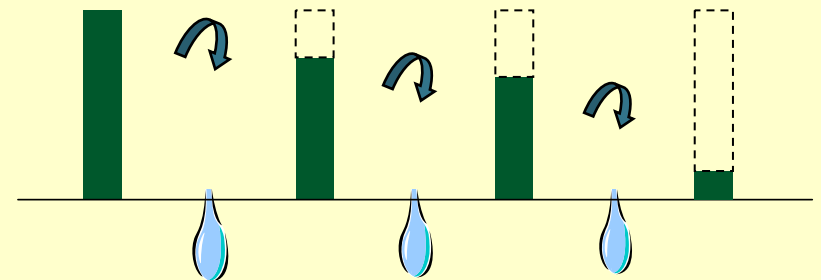
Situation:

- One vaccine candidate advancing in clinical trials, multiple candidates in pipeline

Objectives:

- Determine global demand for a range of malaria vaccines
 - public, private, military, and travelers markets
 - through 2025
- Identify demand hurdles, drivers, and sensitivities
- Highlight areas where current actions could make a difference

Our framework



How many people would benefit?

How many people would be candidates?

How many candidates likely to receive it?

How many likely given attitudes and strategies?

Focus on creating more complete information to inform:

- Manufacturing capacity
- Capital investments
- Design of clinical trials
- “Fair value” agreements
- Portfolio management
- Rapid uptake

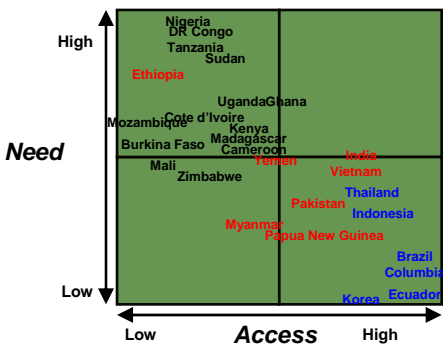
PROJECT COMPLETED VIA THREE-PHASED APPROACH

Conducted Across Both Endemic Countries and Special Populations

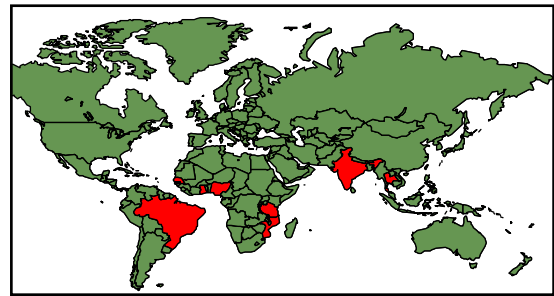


Objective

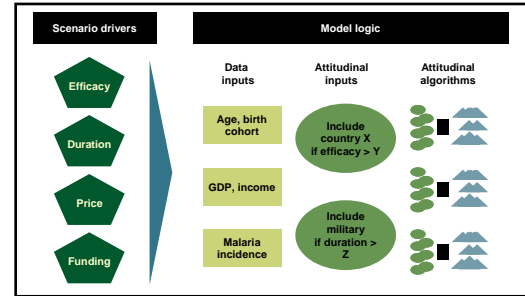
Situation analysis for endemic countries and select populations



Evaluation of demand drivers and barriers



Demand model for vaccine, including scenario and sensitivity analyses



Key activities

- Secondary source review
- Analog studies
- Country segmentation
- Product profiles

- Primary research
 - 8 endemic countries
 - travel and military mkts
 - donors, policymakers, and KOLs

- Additional interviews
- Interactive model
- Sensitivity and scenario testing
- Synthesis of findings

Project completed over 20 weeks in 2004-2005

PRIMARY RESEARCH CONDUCTED IN EIGHT ENDEMIC COUNTRIES AS WELL AS WITH GLOBAL DONORS AND EXPERTS

Over 200 Interviews Conducted

Endemic countries

Endemic countries

- Brazil
- Mozambique
- Ghana
- Nigeria
- Senegal
- Tanzania
- India
- Thailand

Sample interviews

- Ministry of Health
- Ministry of Finance
- WHO
- Hospitals
- Director of Health, Multinational corp.
- Local operations of bilaterals and multinationals

Key criteria used for primary research countries

Need:

- Population at-risk
- Malaria burden
- Transmission setting

Access/attitude:

- Malaria readiness
- Healthcare expenditures
- Reach of HC facilities
- Geography/culture

Global organizations and experts

Global organizations

- Health Advisor, DFID
- Sr Health Specialist, World Bank
- Secretariat, RBM
- Sr Advisor for Malaria in Health Sector, UNICEF



Military

- Science Dir., WRAIR
- Dir, Army Malaria Vaccine Program
- Public health physician, British Forces

Walter Reed Army Institute of Research

Travelers

- Sr Lecturer, London School of Hygiene and Tropical Medicine
- Dir, Travel Clinic, Mass. General Hospital
- Dir, Ctr. for Travel and Tropical Med. (Toronto)

FINDINGS INCORPORATED INTO AN ADAPTIVE MODEL USED TO PREDICT VACCINE DEMAND

Flexible Tool to Run Scenarios and Sensitivities

A flexible and adaptable tool

Model uses base case to incorporate primary research findings and predict demand

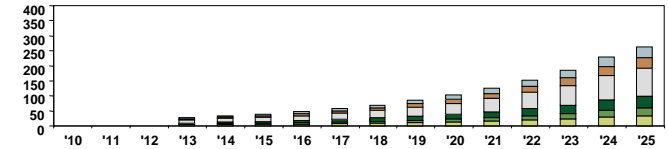
- Inputs are variable and inter-relationships have been built across variables

Therefore, can develop and test complex scenarios around:

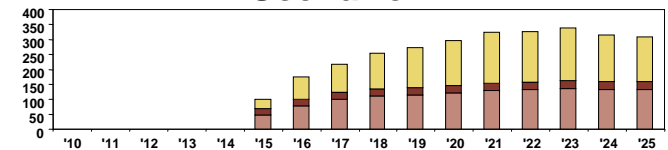
- Product profile
- Country-specific inputs
- Attitudes
- Other

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

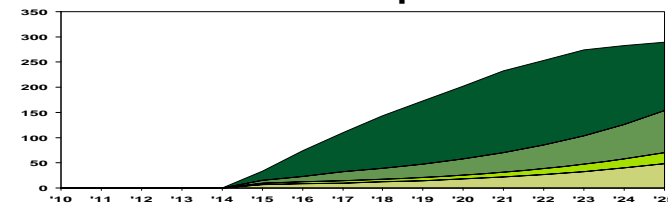
Scenario 1



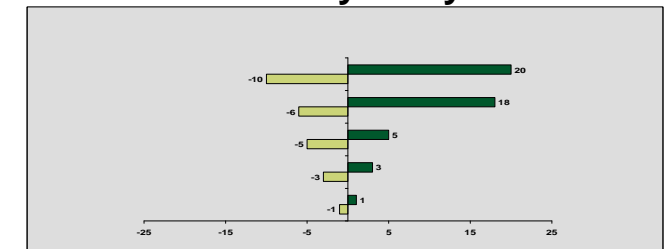
Scenario 2



Scenario comparison



Sensitivity analysis



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PUBLIC MARKET VACCINE MUST BE COST EFFECTIVE, FINANCIALLY SUSTAINABLE, AND EASY TO ADMINISTER

Attribute	Impact on demand	Details	Comments
Efficacy	High	Clinical efficacy threshold: 30%-W Africa, 50%-E Africa, 80%-SE Asia	Countries will compare efficacy against ITNs and other preventative tools - KOL, Senegal
Duration	Medium	Duration threshold: one year	Benefit of protecting children early in life, until they develop partial immunity - Donor, Tanzania
Cost	High	Cost/efficacy needs to compete with existing interventions May require donor support and sustainability plan	Duration impacts cost - Govt official, Mozambique Financial sustainability a huge issue - Global NGO
Species	High	<i>P. falciparum</i> most important in Africa and Asia vs. <i>P. vivax</i> in Brazil	We're most concerned about <i>P. falciparum</i> —it is the most deadly - Global NGO
Population segment	Low	Relevant to infants, children, and pregnant women in Africa vs. adults in SE Asia, S America	Pregnant women and under fives are highest priority - KOL, Tanzania
Administration	High	Prefer to give vaccine with existing EPI schedule	Only realistic way to implement vaccine is through EPI schedule - NGO Senegal

STAKEHOLDERS ACROSS COUNTRIES AGREE ON REQUIREMENTS FOR CERTAIN PRODUCT PROFILE CHARACTERISTICS

Malaria endemic countries

Duration

Most stakeholders agree that one year minimum is important

- 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 two years could 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 likely 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”

VACCINE RELEVANT FOR HIGH-RISK POPULATIONS IN AFRICA VS. TOTAL POPULATION IN HIGH-RISK AREAS IN SE ASIA/ S. AMERICA

Africa

SE Asia / South America

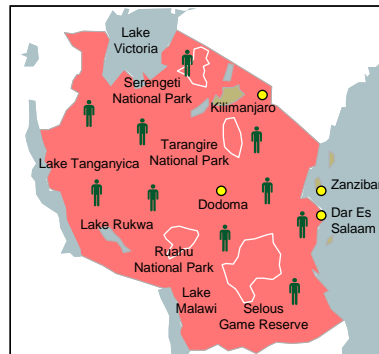
Population

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

- In Brazil, Thailand, India, etc, malaria only present in border areas
- Vaccine considered relevant for all ages in India and Brazil, but primarily for adults in Thailand

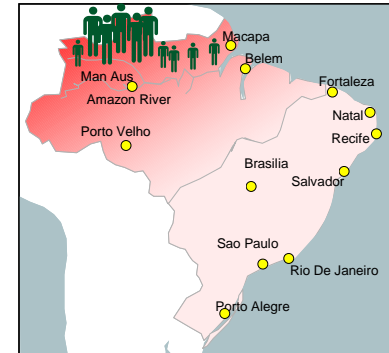
Tanzania

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

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EFFICACY AND COST HURDLES DIFFER FOR AFRICAN COUNTRIES VS. SE ASIA/ S. AMERICA

Africa Typically Has Lower Efficacy Threshold and Higher Cost Sensitivity

Africa

SE Asia / S America

Efficacy

- Impact on clinical disease critical
- Impact on severe disease may not influence introduction decisions
- RTS,S data viewed as promising
- W. Africa hurdle: ~30% against clinical and ~50% against severe disease
- E. Africa hurdle: ~50% against clinical

- Impact on clinical disease very important
 - Thailand focused on severe disease efficacy due to increasing drug resistance
- P. falciparum more important to India and Thailand; P. vivax more important to Brazil
- Hurdle: ~80-90% against clinical disease

Cost

- Population expects vaccine to be free
 - majority of population cannot afford even \$1-3/dose
- Governments will evaluate cost effectiveness of vaccine vs. malaria control portfolio
- Donor funding critical
- Some countries will refuse upfront financing without clear path to sustainability

- Wealthier governments expected to purchase vaccine; donors important in poorer nations
 - Thailand: higher cost vaccine affordable
 - India: cost of rolling out to even high risk groups would be prohibitive
- Governments will evaluate cost/benefit of vaccine vs. malaria control portfolio
- Some countries will refuse upfront financing without clear path to sustainability

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

Source: BCG interviews, BCG Analysis
70685-02-DFID Meeting-17Jan05-BW-BOS.ppt

KEY TAKEAWAYS

Public Market

Significant need for malaria vaccine in public market despite breadth of existing alternatives

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

Product profile threshold varies by geography, but with a consistent focus on *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 for vaccine purchase and infrastructure enhancement requirements in African countries

- **Increasing focus on long-term sustainability of donor supported programs**
- **Wealthier SE Asian / S. 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 / S. American countries, government and local stakeholders key**

Hurdles vary across geographies, but include perception of need and of vaccines, credibility and communication issues for partial effective vaccines, and desire for local clinical data

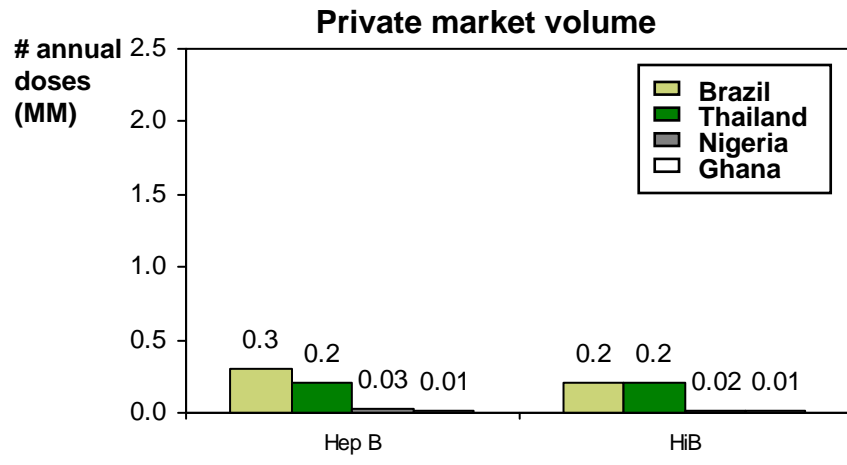
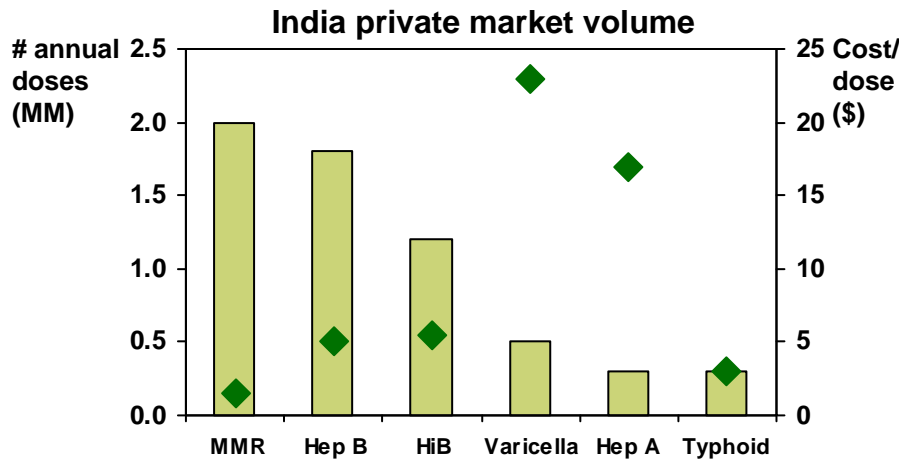
PRIVATE MARKET MOST CONCERNED THAT VACCINE BE HIGHLY EFFICACIOUS

Attribute	Impact on demand	Details	Comments
Efficacy	High	Most important factor given need to seek out vaccine; efficacy has to warrant time and money invested	Private market acceptance likely with high efficacy - Global KOL
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	Cost of vaccine would have to be comparable to current interventions for use in the private market - Govt Official, Senegal
Species	High	Vaccine for <i>P. falciparum</i> more important given severity of disease	
Population	Medium	Private market vaccine applicable to adults as well as other high risk groups	
Administration	Low	Individuals more likely to comply with multiple doses / boosters	

PRIVATE MARKET LIKELY SMALL, EXCEPT IN MORE WEALTHY AND POPULOUS COUNTRIES SUCH AS INDIA

Extensive vaccine private market in India

Vaccine private market 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 very high income class who prefer private facilities

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

HURDLES INCLUDE INADEQUATE INFRASTRUCTURE, LIMITED CLINIC ACCESS, REGULATIONS, AND CULTURAL ATTITUDES

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

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

Attitude

- Cultural expectation in most endemic countries is to obtain health services from the government
- Standard vaccines and malaria interventions often free of charge

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-sensitivity lower 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
- 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, regardless of affordability

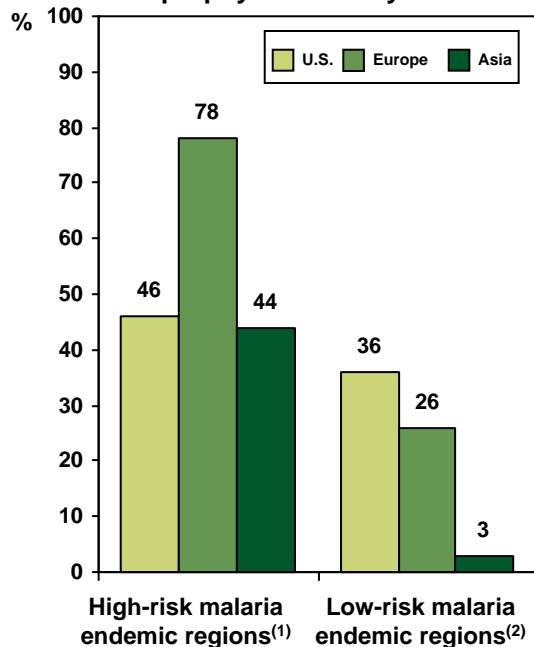
PRE-TRAVEL BEHAVIOR AND DURATION OF TRIP CRITICAL FOR SUCCESS OF POTENTIAL MALARIA VACCINE

Many travelers do not take chemoprophylaxis

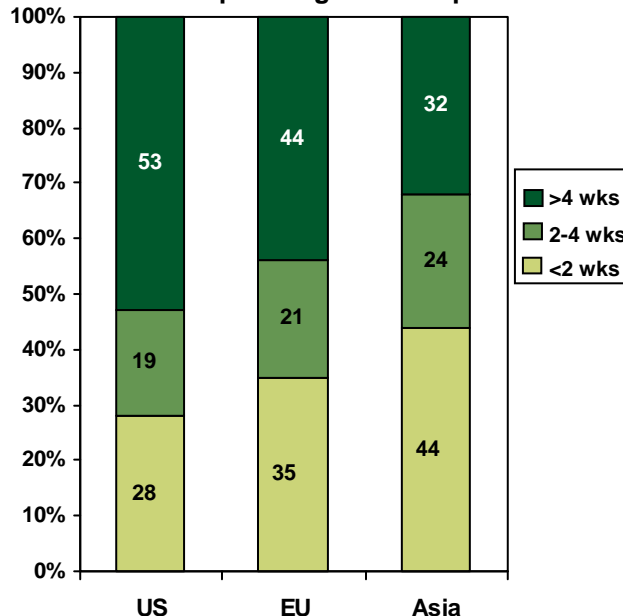
~50% of travelers plan < 4 weeks in advance of their trip

~60% of travelers remain at their final destination for < 2 weeks

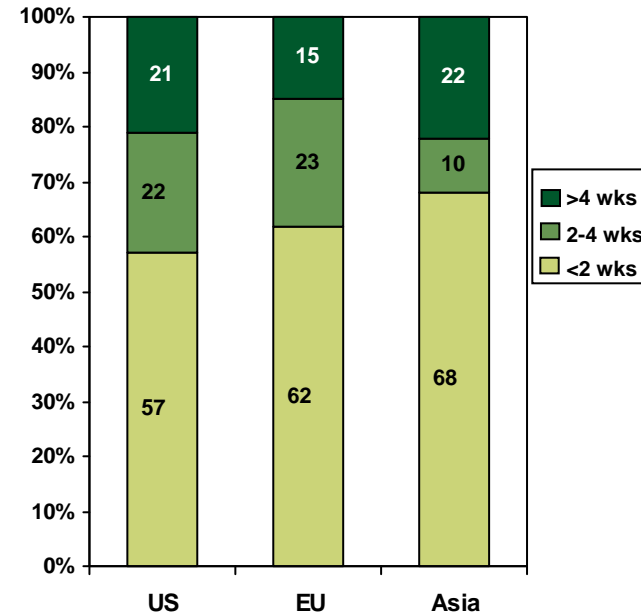
Chemoprophylaxis use by destination



Time planning before trip



Time at destination



Vaccine most likely useful for travelers who plan in advance and/or take long trips

(1) High-risk destinations vary by study. Asia: all rural/jungle areas except for N. China, Singapore, Taiwan and Japan. All Sub-Saharan countries. Ghana, Nigeria, Liberia, Tanzania and Kenya. Tropical Africa, Papua New Guinea and Solomon Islands with regional and seasonal exceptions

(2) Low-risk destinations: Europe. Rural areas of Brazil, Ecuador, DR, China, The Philippines, Thailand, Guyana and El Salvador. U.S., Endemic regions in Latin America, Asia and Southern Africa

Source: Combined studies: Journal of Travel Medicine: "Travelers' Knowledge, Attitude and Practices on the Prevention of Infectious Diseases," "Travel Health Knowledge, Attitudes and Practices among U.S. travelers," "Travelers Knowledge, Attitudes and Practices on Prevention of Infectious Diseases: Results from a Pilot Study," "Travel Health Knowledge, Attitudes, and Practices among Australasian travelers"

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, duration of trip, and attitude toward vaccines

- **78% of Europeans going to high-risk areas take prophylaxis vs. 46% of Americans**
- **~50% of travelers plan trips less than four weeks in advance**
- **~60% of travelers spend less than two weeks in destination region**

Key demand drivers are efficacy, timing of immunization, education, duration of trip

- **Vaccine must compete with available prophylaxis (~98%)**
- **Vaccine most useful if effective within a month of travel**
- **Market limited by people seeking qualified pre-travel health advice**
- **Vaccine most useful for people remaining at their destination for long periods of time**

Ultimate demand will depend on product profile trade-offs with available prophylaxis options

PROTECTING SOLDIERS' HEALTH IS A PRIORITY FOR THE MILITARY

Malaria Poses Threat to Troop Preparedness

Focus on readiness and preventing illness

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

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

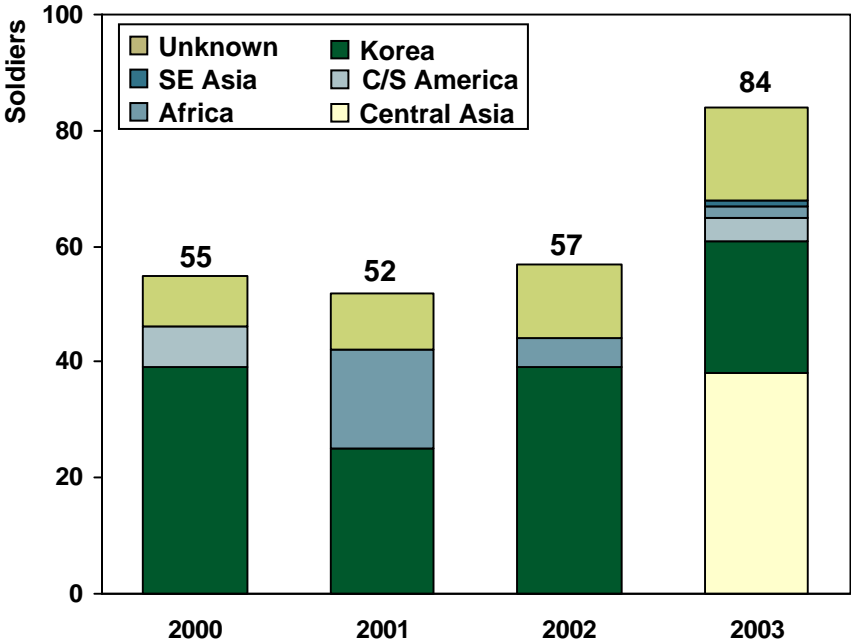
“Once military personnel are sick, they are useless on a mission” –WRAIR

“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

Malaria is a current threat to deployed troops

U.S. military malaria incidence (2000-2003)



“Last year in Liberia about 40 U.S. marines were evacuated and 5 were admitted to intensive care units, almost compromising the mission”- WRAIR

KEY TAKEAWAYS

Military Market

Preparedness is essential to maintaining an alert force

Malaria incidence is problematic for militaries

- **Mostly 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. U.S., UK, Japan), but may significantly affect demand from militaries with smaller budgets**

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Research findings

- **Endemic public market**
- **Endemic private market**
- **Travelers market**
- **Military market**

Demand model methodology

Predicted vaccine market size

Key findings

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

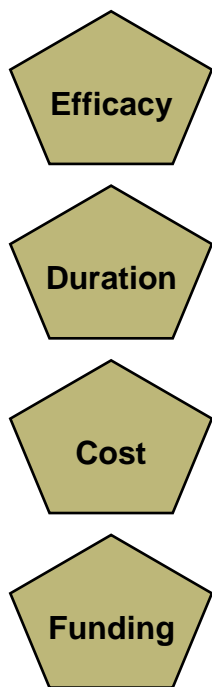
Concrete

Generate actual demand forecast ranges and sensitivities that are as accurate as possible given current data availability

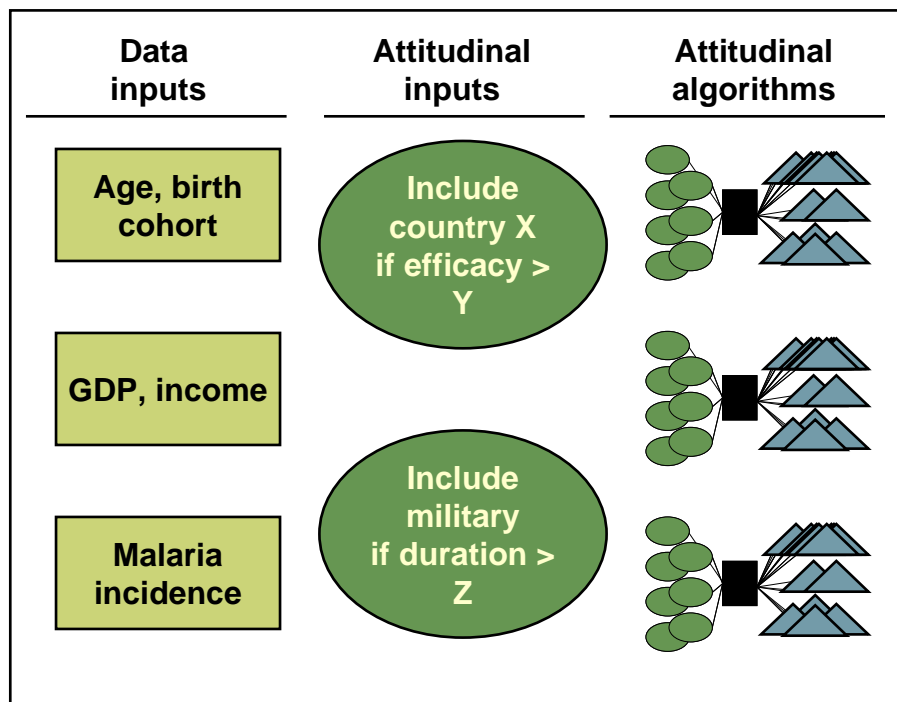
DEMAND MODEL USES SCENARIO DRIVERS, DATA INPUTS, AND ATTITUDINAL ALGORITHMS TO FORECAST DEMAND

Sample Information Flow – Does Not Represent Full Scope of Model

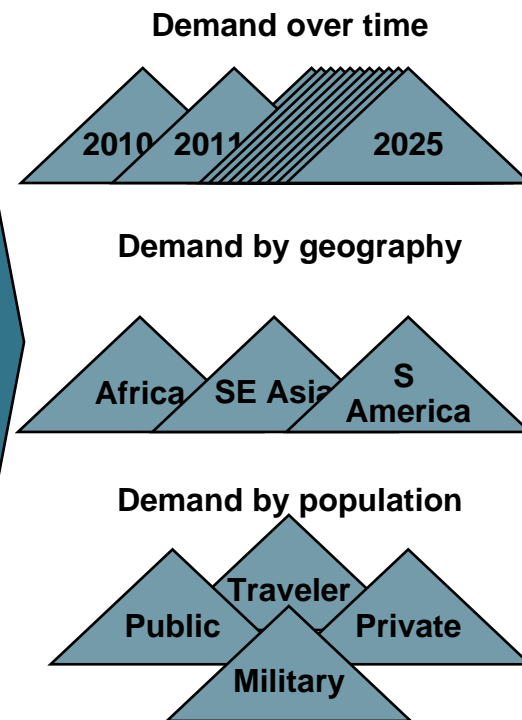
Scenario drivers



Model logic



Modular outputs

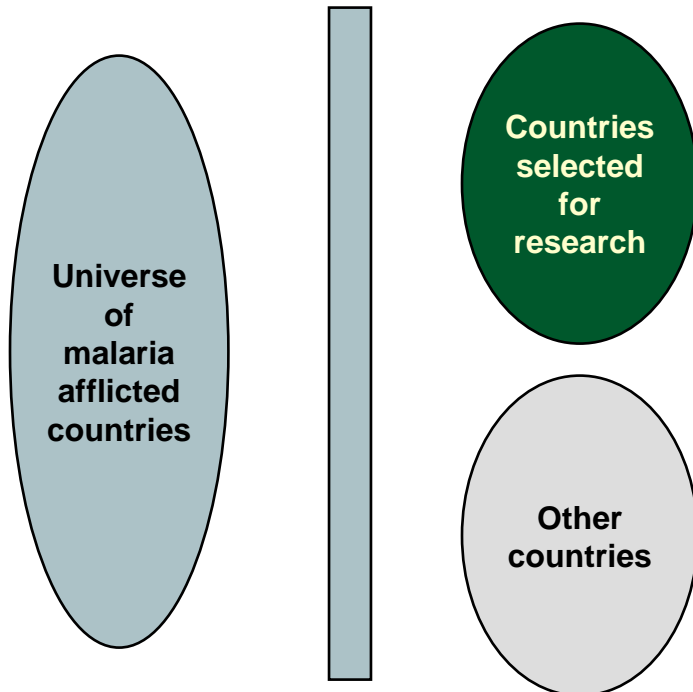


Model has flexibility to accommodate changes in vaccine landscape and country characteristics over time

PRIMARY RESEARCH FINDINGS WERE EXTRAPOLATED TO ALL ENDEMIC COUNTRIES VIA CLUSTERING METHODOLOGY

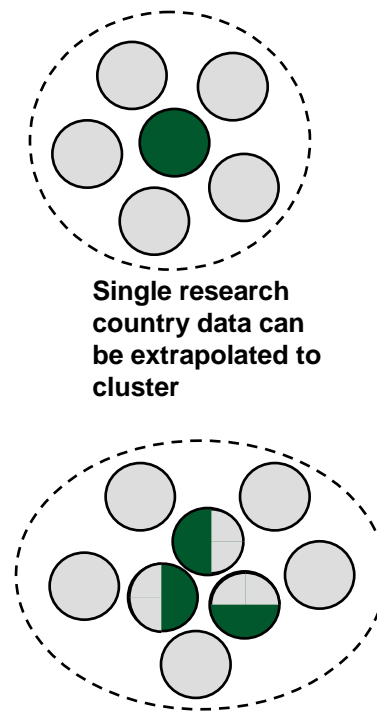
Clustering methodology

Country segmentation and selection for research



Based on need and access/attitude

Country mapping



Single research country data can be extrapolated to cluster

Based on similarity of malaria related characteristics
Combination of research country data can be extrapolated to cluster

Application in model

Model minimizes the need to cluster to increase accuracy

- Majority of inputs objective and specific to countries

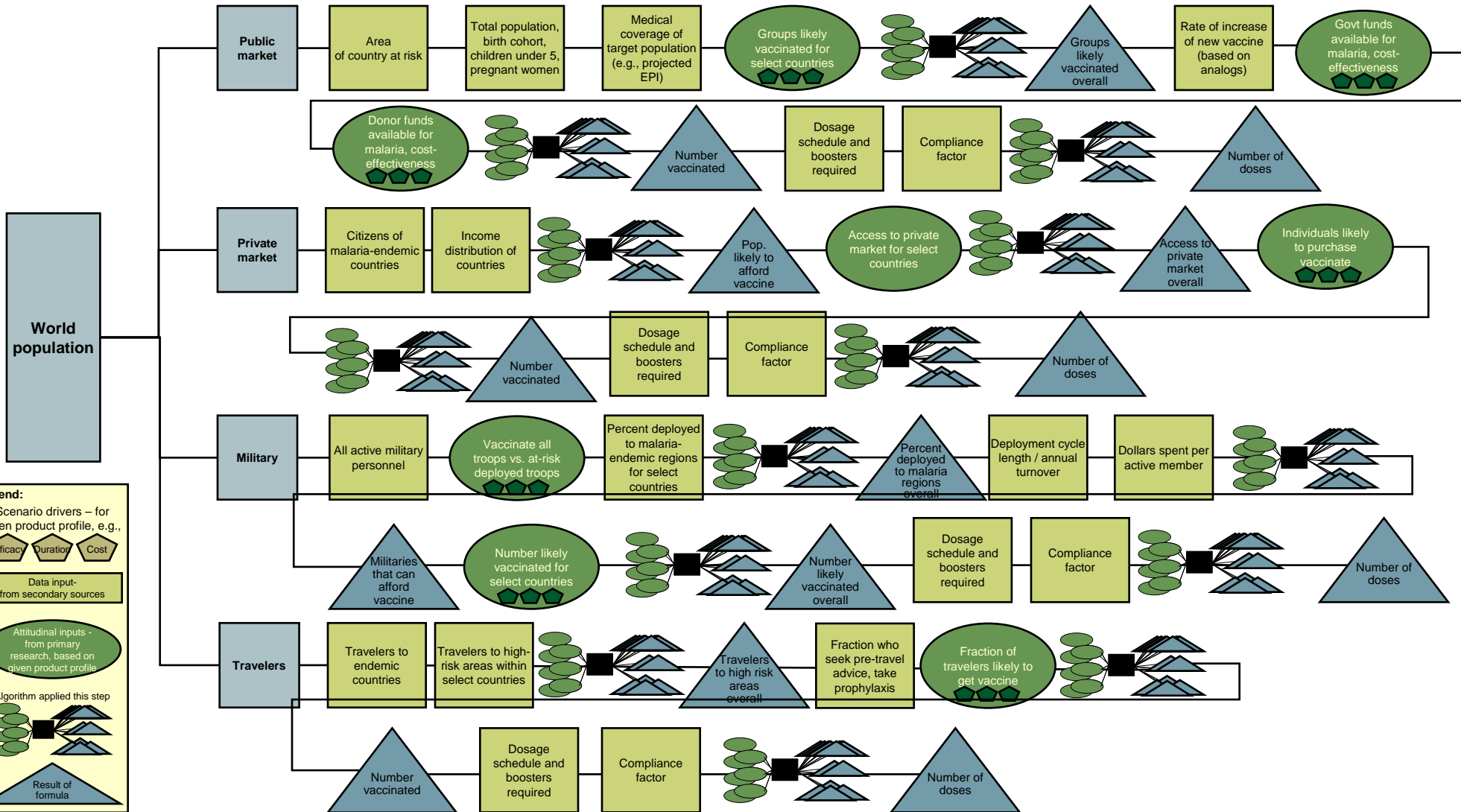
Country specific inputs include:

- 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 populations segments
- Segments likely to have access to private market

FOUR KEY MODULES IN THE MODEL PROJECT DEMAND FOR PUBLIC, PRIVATE, MILITARY AND TRAVELERS MARKETS



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- Public market
- Private market
- Travelers and Military markets

Key findings

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 \$5 incremental delivery cost per course

Funding availability

- Donor support malaria programs at current level, ~\$300 MM/year
- Vaccine funding 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, > 5 in 2011 and in adults in 2012
- Post-licensure lag 5 years in Africa, 3 – 4 years ROW

Uptake in markets

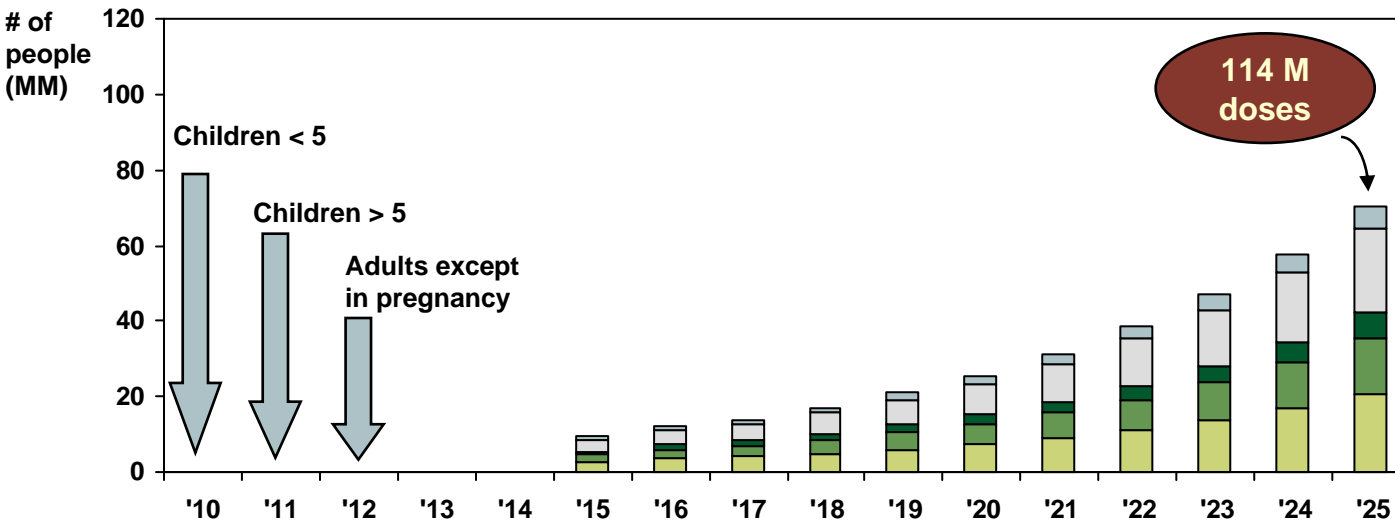
- Maximum coverage based on EPI performance on DPT projected into the future
- Change in coverage based on past experience with new vaccine introduction

BASE CASE: 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 lag, uptake begins 5 years after vaccine approval

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

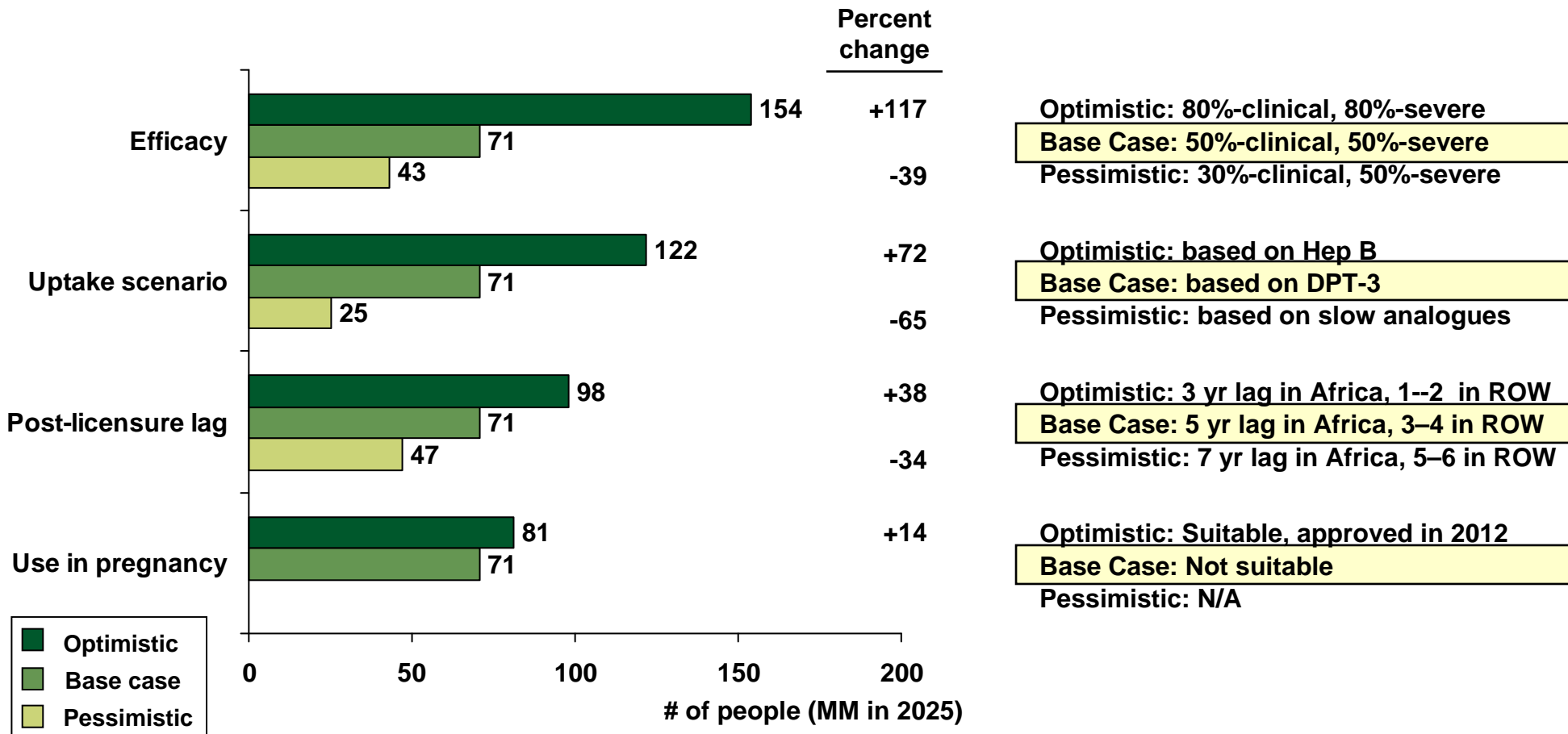
Demand estimate assumes sufficient funding is available to fund all doses



DEMAND FOR A MALARIA VACCINE MOST SENSITIVE TO EFFICACY AND UPTAKE SCENARIOS

For Demand Unconstrained By Funding

Sensitivity of funding unconstrained demand to model inputs (2025)



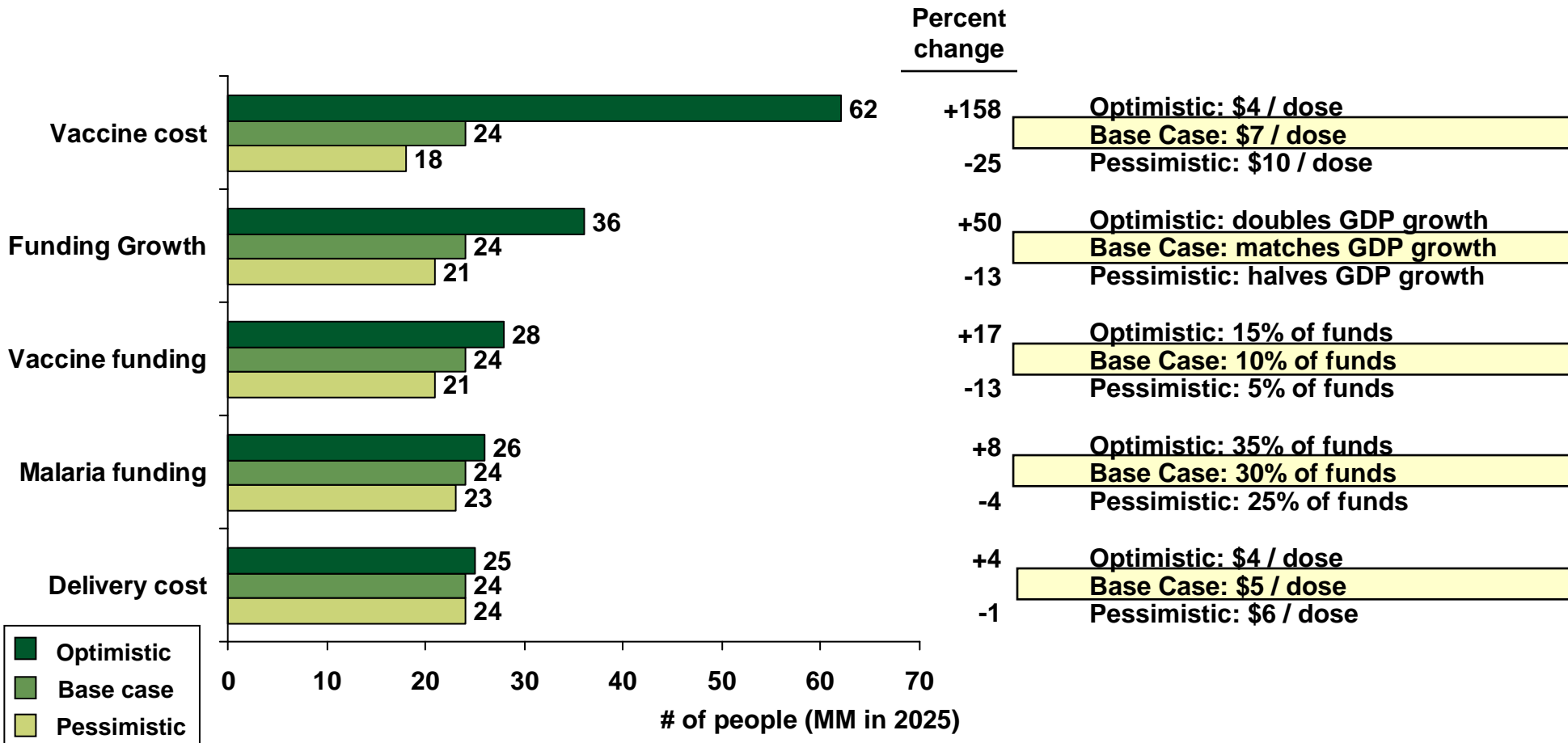
Note: Sensitivity to demand drivers keeping all other variables constant at base-case levels; ROW: Rest Of the World

Source: BCG analysis
70685-02-DFID Meeting-17Jan05-BW-BOS.ppt

DEMAND FOR A MALARIA VACCINE ALSO VERY SENSITIVE TO COST AND FUNDING GROWTH

At Current Funding Levels

Sensitivity of funded demand to model inputs (2025)

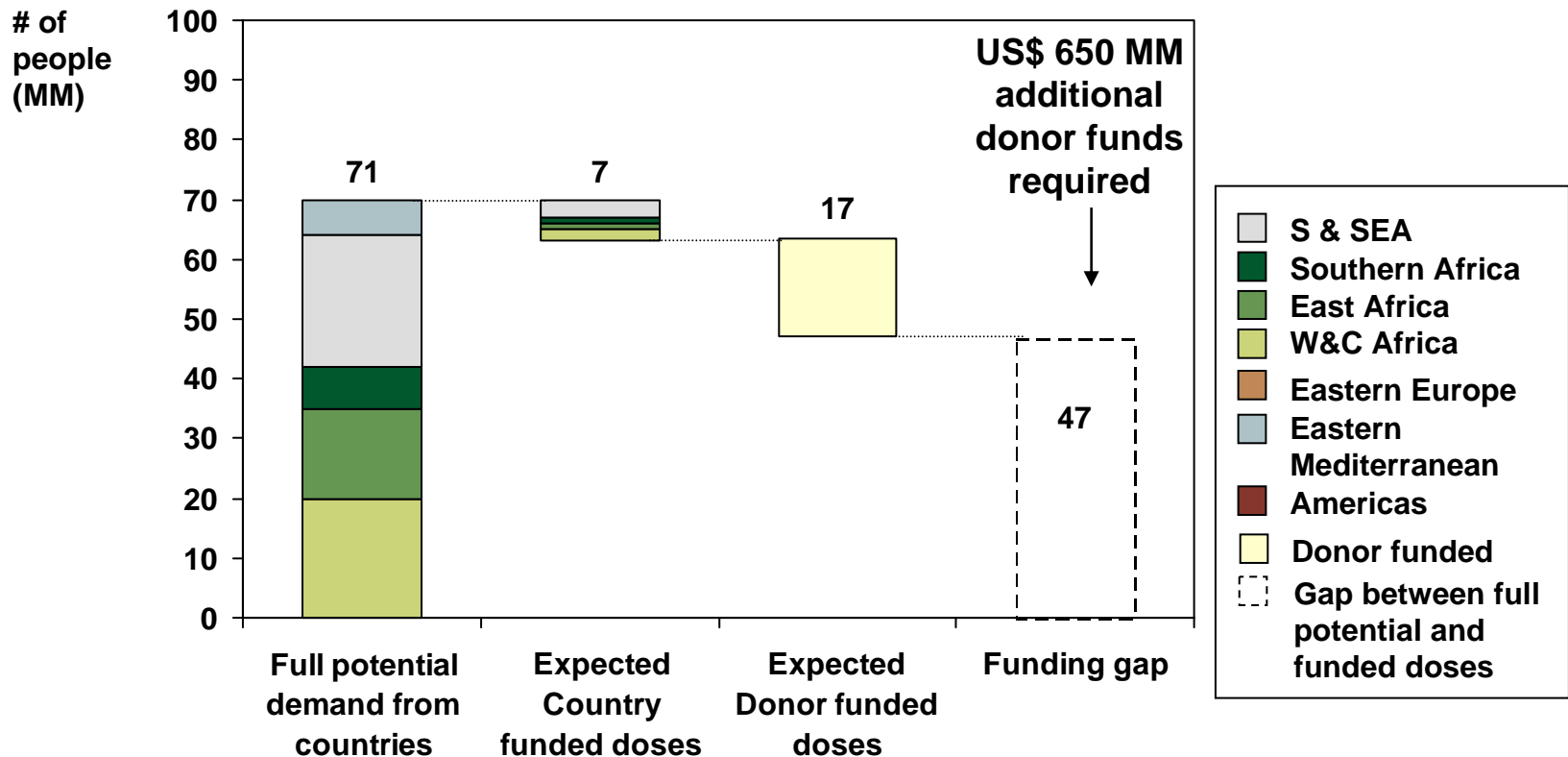


Note: Sensitivity to demand drivers keeping all other variables constant at base-case levels

Source: BCG analysis
70685-02-DFID Meeting-17Jan05-BW-BOS.ppt

FUNDING SCENARIO: 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)



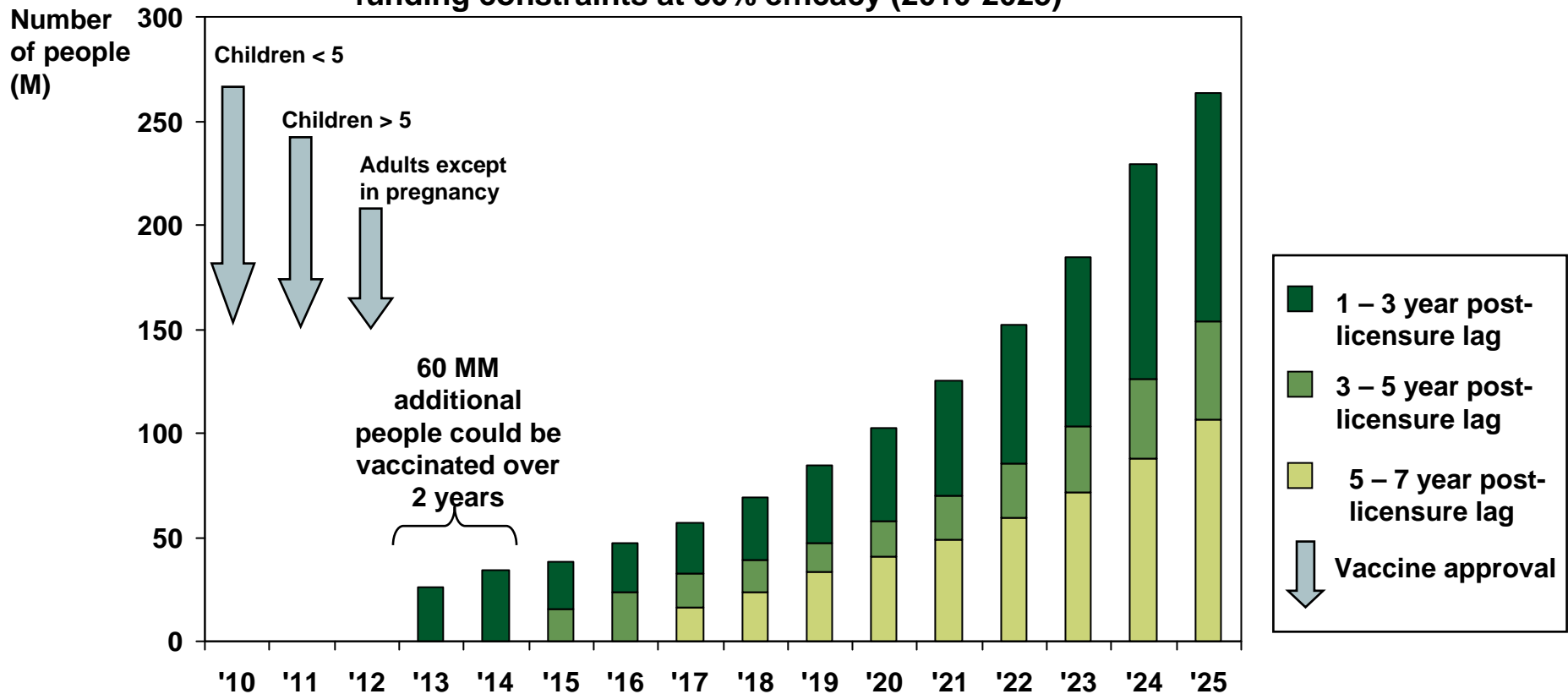
Donor activity at the current level insufficient to fund full potential demand, 47 MM additional people could be protected with full funding

Note: Assuming current levels of donor activity in the future
 Source: BCG analysis
 70685-02-DFID Meeting-17Jan05-BW-BOS.ppt

UPTAKE SCENARIO: REDUCING POST-LICENSURE LAG BY 2 YEARS COULD INCREASE DEMAND BY 60 MM PEOPLE

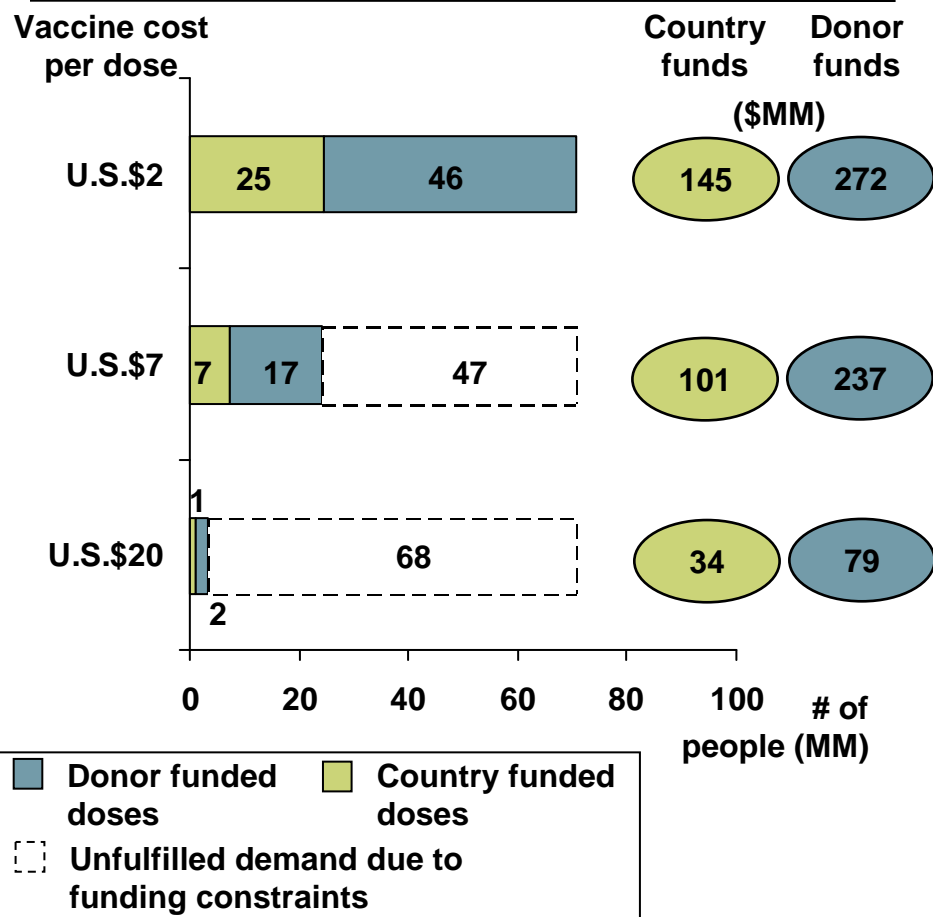
For An 80% Efficacious Vaccine

Estimated vaccine demand with no funding constraints at 80% efficacy (2010-2025)



COST SCENARIO: FOR US\$2 / DOSE VACCINE, ALL OF DEMAND COULD BE FUNDED AT CURRENT DONOR ACTIVITY LEVELS

Estimated vaccine demand with funding for 50% efficacy at varying costs (2025)



Key messages

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

Higher proportion of demand being fulfilled at lower cost, assuming current funding levels

- 100% of demand fulfilled for \$2/dose vaccine
- 5% of demand fulfilled for \$20/dose vaccine

Note: All cost scenarios assume similar incremental vaccine delivery cost of U.S.\$ 5 / course, all U.S.\$ values refer to 2003 U.S.\$

Source: BCG Analysis

70685-02-DFID Meeting-17Jan05-BW-BOS.ppt

SUMMARY OF PUBLIC MARKET DEMAND

Base case

70 MM people could receive a 50% efficacious vaccine priced at U.S.\$ 7 / dose in 2025 if sufficient funding is available

- Only 35% of potential demand likely to be funded at current donor activity
- 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

Efficacy

Demand for an 80% efficacious vaccine as high as 154 MM people in 2025 with unconstrained funding

- 76% of demand for an 80% efficacious vaccine likely to be funded in 2025
- Demand for 80% efficacious vaccine in any given year more than twice that for a 50% efficacious vaccine

Time of introduction

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

Market uptake

Advocacy and implementation support from donors could lead to 140 MM more people vaccinated in 2025

- By affecting fundamental access issues and improving government's ability to deliver vaccines

Cost

A low cost vaccine could reach full potential demand for a 50% efficacious vaccine

- U.S.\$ 7 vaccine can be fully funded till 2019, \$ 2 vaccine can be fully funded throughout

Sensitivity

Demand most sensitive to efficacy, cost, funding growth and market uptake rates

AGENDA

Project overview

Research findings

- Endemic public market
- Endemic private market
- Travelers market
- Military market

Demand model methodology

Predicted vaccine market size

- Public market
- Private market
- Travelers and Military markets

Key findings

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: U.S.\$ 15/dose and \$5 delivery cost per course

Vaccine affordability

- Families are willing to spend up to 2 weeks of annual household income to vaccinate household members

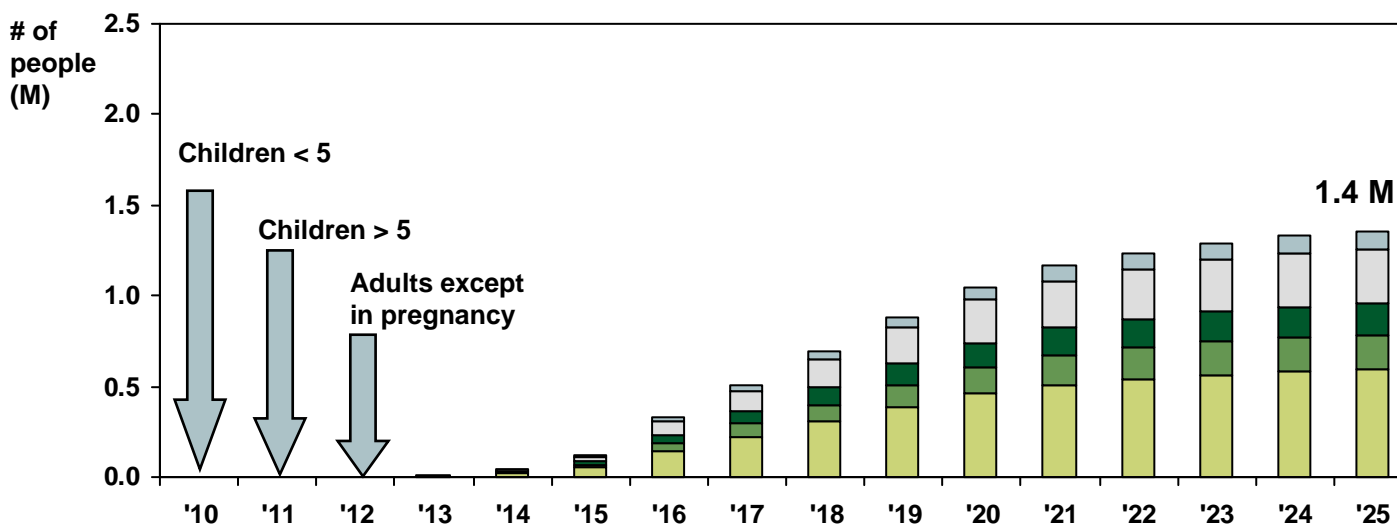
Timing of introduction

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

BASE CASE: 1.4 MM PEOPLE LIKELY TO BUY A 50% EFFICACIOUS VACCINE, 70% FROM AFRICA

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

Key messages

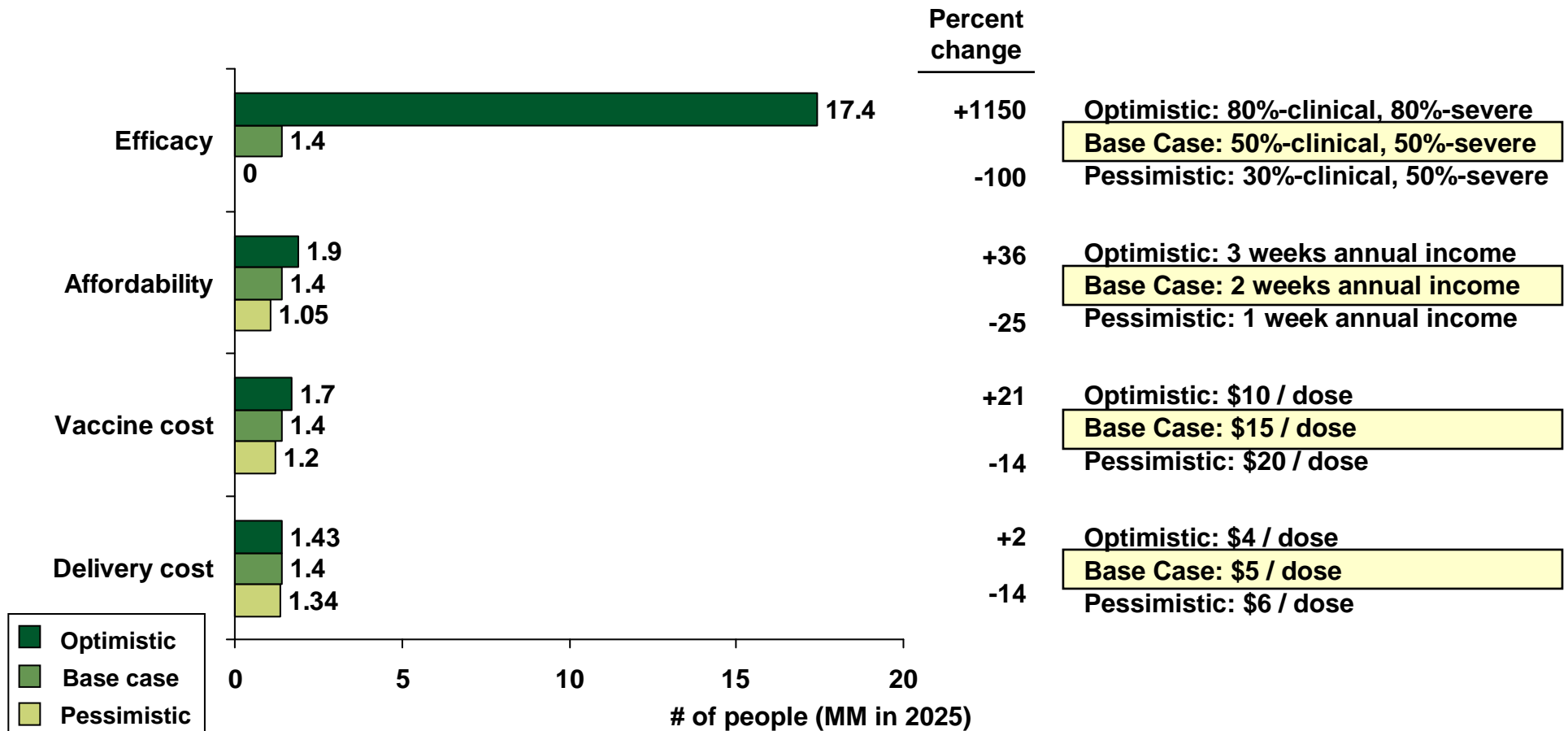


- Post-licensure lag may be shorter in private market**
- As vaccine adoption and funding constraints typically delay public market uptake
- Majority of demand from Africa due to lower efficacy levels of vaccine**



PRIVATE MARKET DEMAND FOR A MALARIA VACCINE MOST SENSITIVE TO EFFICACY

Sensitivity of private market demand for 2025 to model inputs



SUMMARY OF PRIVATE MARKET DEMAND

Base case

- 1.4 MM people likely to buy a 50% efficacious vaccine, 70% from Africa
- Limited uptake from regions outside Africa where higher efficacy needed

Efficacy

- 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 >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. Thailand at 80%)
 - affordability of vaccine to country populations

Time of introduction

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

Affordability

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

Cost

- At \$15/dose, 1.4MM people could be vaccinated, compared to 1MM at \$30/dose and 1.7MM at \$10/dose
- Private market driven by two sub-segments of the high income population in countries
 - a very high income group which is relatively price insensitive
 - a lower income group which is sensitive to price

Sensitivity

Demand estimates most sensitive to efficacy

SUMMARY OF TRAVELERS AND MILITARY MARKET DEMAND

Travelers market

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
- Travelers staying >4 weeks and planning >4 weeks pre-trip will consider a vaccine
- Demand sensitive to assumptions on average number of trips per person per year

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

Military market

Military market likely to be in the range of 0.7 MM people in 2025 for a 50% efficacious vaccine costing \$15/dose

- Demand likely only from non-endemic country militaries at 50% efficacy levels
- Demand for \$50/dose vaccine likely 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 U.S.\$ 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 \$50/dose instead of \$15/dose

AGENDA

Project overview

Research findings

- **Endemic public market**
- **Endemic private market**
- **Travelers market**
- **Military market**

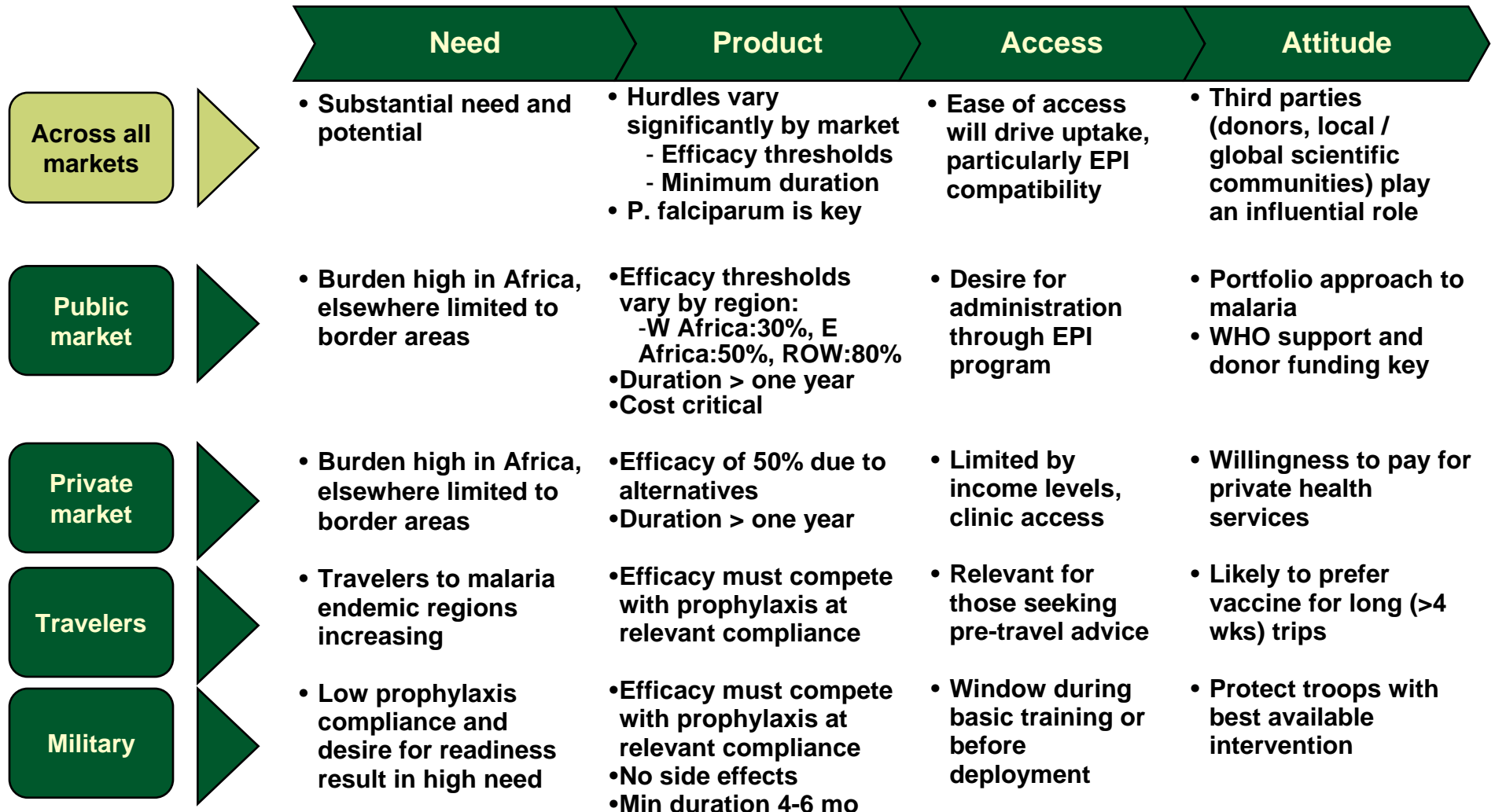
Demand model methodology

Predicted vaccine market size

Key Findings

KEY FINDINGS BY MARKET

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



THREE FACTORS CRITICAL TO SUCCESS OF MALARIA VACCINE: PRODUCT PROFILE, INFLUENCER SUPPORT, AND DONOR FUNDING

Product profile

Vaccine must reach thresholds to have any uptake

- Efficacy and cost are key drivers
- *P. falciparum* target and one year duration are minimum requirements

Influencer support

Support of WHO, academics, and standards-setting organizations are essential to vaccine's introduction and credibility

- Third-party support can reduce lag between licensure and introduction
- Countries and donors both rely on key opinion leaders and WHO recommendations in deciding on which interventions to support

Donor funding

Donors can stimulate early markets and enable less wealthy countries' purchase and administration of vaccine

- Can improve uptake through advocacy and implementation support
- Sustainability of funding is critical for both supply and uptake
 - suppliers need sizable long-term demand guarantee to justify investment
 - poorer countries need sustainability plan before adopting new technology

Advanced purchase contracts could be important vehicle to drive uptake

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