MALARIA: PAST, PRESENT, AND FUTURE

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Overview

- Malaria 101: Early history, biology, and epidemiology
- The first push for malaria eradication (1950–1970)
- Worsening of malaria control (1990s)
- New focus and scale-up success (2000–2010)
  - Is eradication possible now?

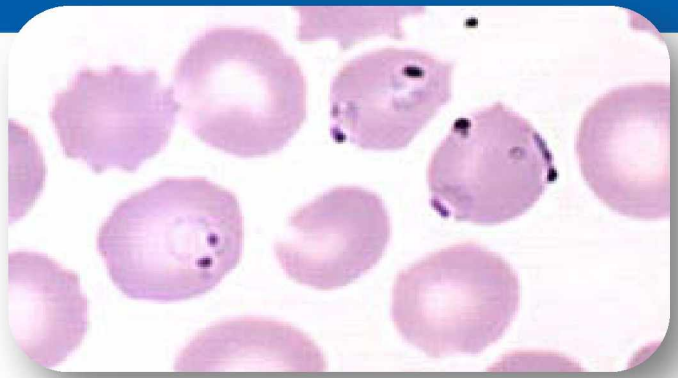
History: Major Scientific Milestones

Charles Alphonse Laveran
Demonstrated parasites in patient's blood, 1880

Ronald Ross
Discovered *Anopheles* mosquito as vector, 1897

Giovanni Batista Grassi
Demonstrated life cycle from mosquito to man, 1898–1899

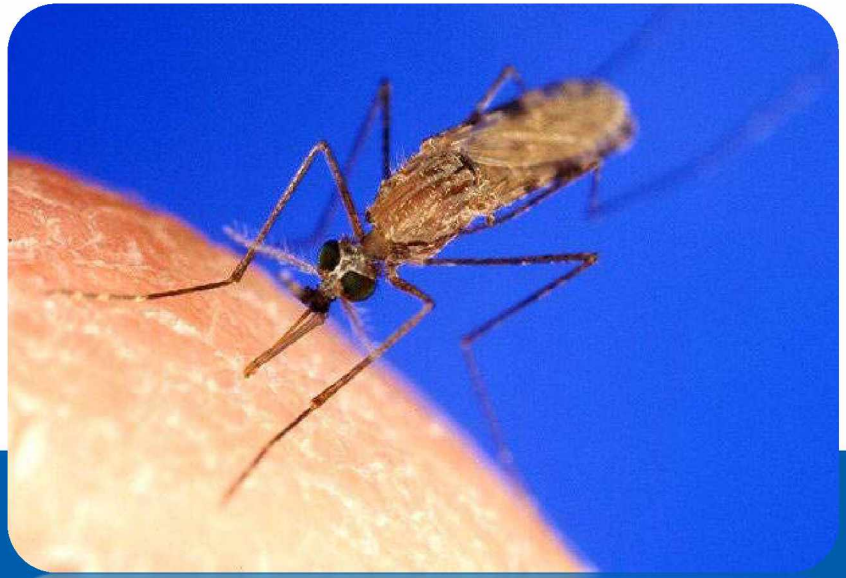
Malaria Biology: The Human Malaria Parasites



- **Intra-erythrocytic protozoan**
- **Human malaria: 4 major species**
  - *Plasmodium falciparum*
  - *Plasmodium vivax*
  - *Plasmodium ovale*
  - *Plasmodium malariae*
- ***P. falciparum***
  - Potentially fatal severe disease
    - Red blood cell destruction →severe anemia
    - Sequestration in cerebral vessels →coma
  - Multi-drug resistant

Malaria Biology: Vectors of Human Malaria

- >400 species of Anopheles mosquitoes found worldwide; ~50 transmit malaria
- Each species occupies distinct ecological niche
- Major African vectors tend to bite indoors and at night
- Biting and resting behavior affect transmission potential and control

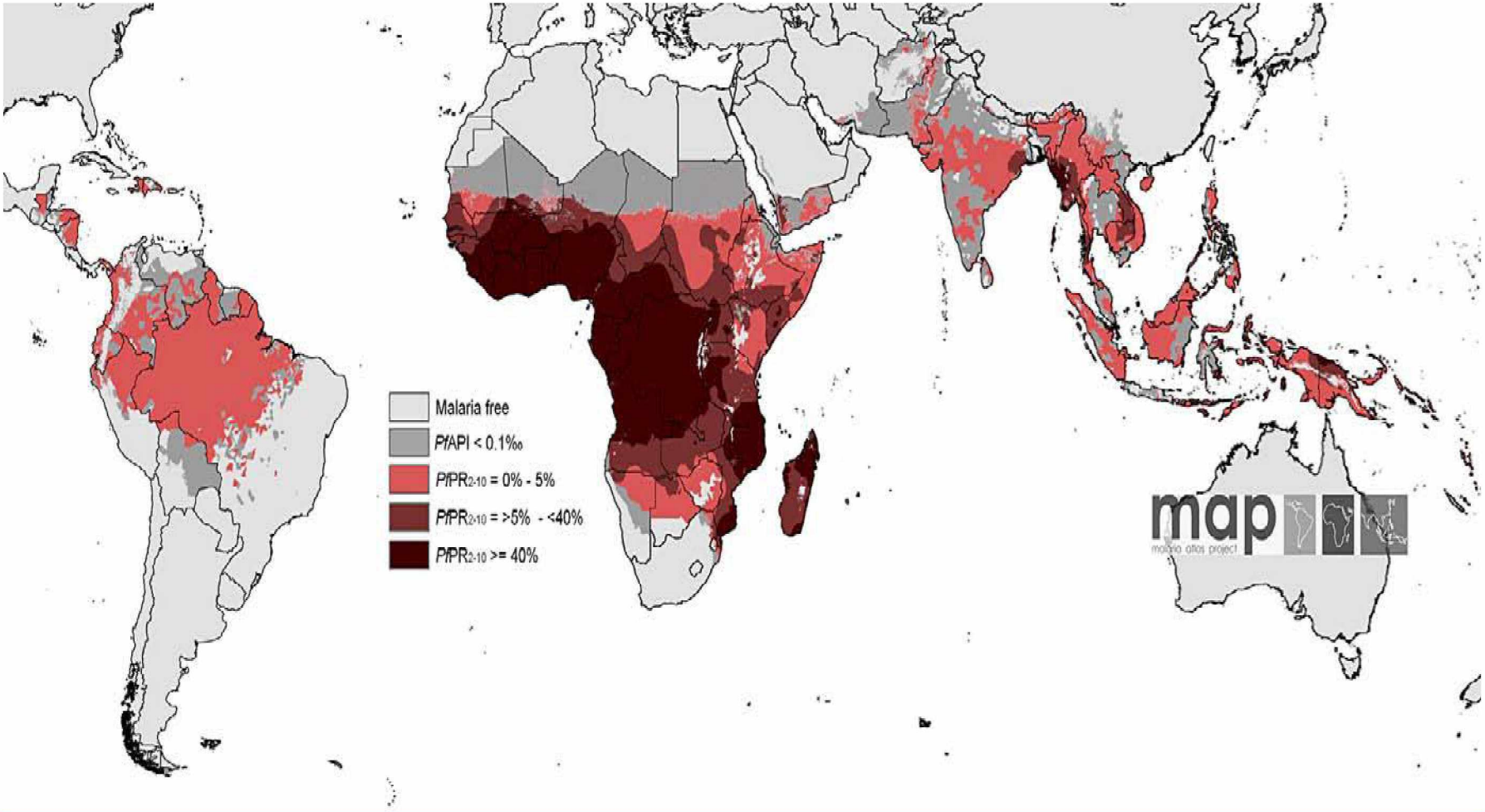


Malaria Global Burden, 2008

- **~250 million clinical cases per year; 80% in Africa**
  - Children aged <5 years and pregnant women most affected
- **>800,000 deaths per year; >90% in Africa**
- **Disability from severe forms of the disease**
- **Annual economic burden**
  - GDP →1.3% loss

GDP, Gross domestic product

Prevalence of *P. falciparum* Malaria in Children Aged 2–10 Years



Hay et al, PLoS Med 2009

Events Leading up to the Global Malaria Eradication Program

- Early successes in mosquito control (Panama Canal)
- Effective interventions, chloroquine and DDT, became available after WWII
- Availability of good diagnosis with microscopy
- 8th World Health Assembly launches Global Eradication Campaign (1955)

DDT, Dichlorodiphenyltrichloroethane

Eradication Strategies 1950–1970

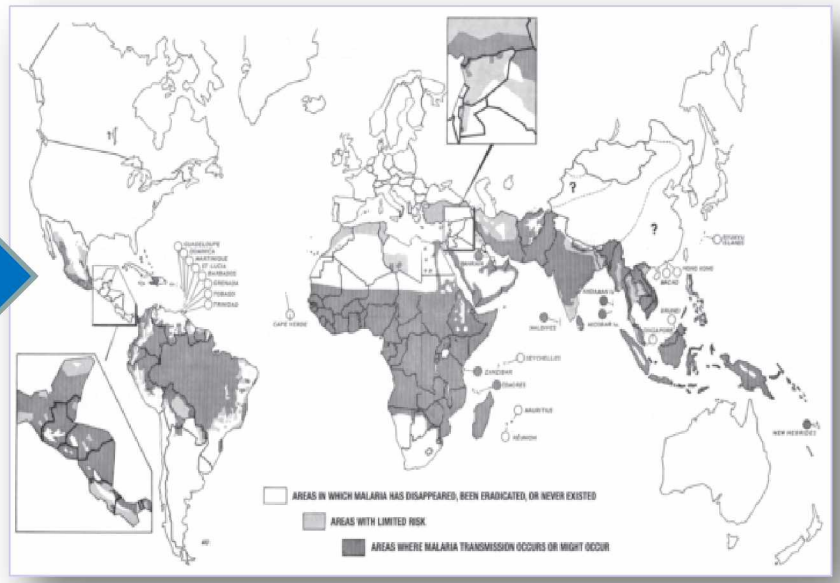
- **"Magic bullet": DDT indoor residual spray (IRS)**
- **Assumptions**
  - People stay indoors at night
  - *Anopheles* mosquito bites at night, rests indoors on house walls, and receives a toxic dose of DDT
- **Other major activities**
  - Antimalarial drug treatment: Patients, occasionally as mass treatment
  - Surveillance to detect and eliminate any reservoirs

DDT, Dichlorodiphenyltrichloroethane

Eradication Successes

Malaria was eliminated in 37 countries during 1950–1978

1950



1978

What Were the Problems?

Technical	Insecticide and drug resistance
Logistics	Supply chain failures Poor delivery of IRS
Strategic	Rigidity Lack of research Africa not included
Financial	Funds diverted elsewhere
Sociocultural	Lack of community buy-in and participation Decreasing acceptance of IRS

IRS, Indoor residual spraying

Consequent Change in Strategy (1970s)

- **22nd World Health Assembly (1969)**
  - "Suspended" eradication campaign
  - Goal became control to "Minimize the health damage by malaria"
    - Less ambitious
    - Strategy adapted to local context
- **Shift from prevention with insecticides/DDT to antimalarial treatment**
- **Integrate activities into primary health care**

DDT, Dichlorodiphenyltrichloroethane

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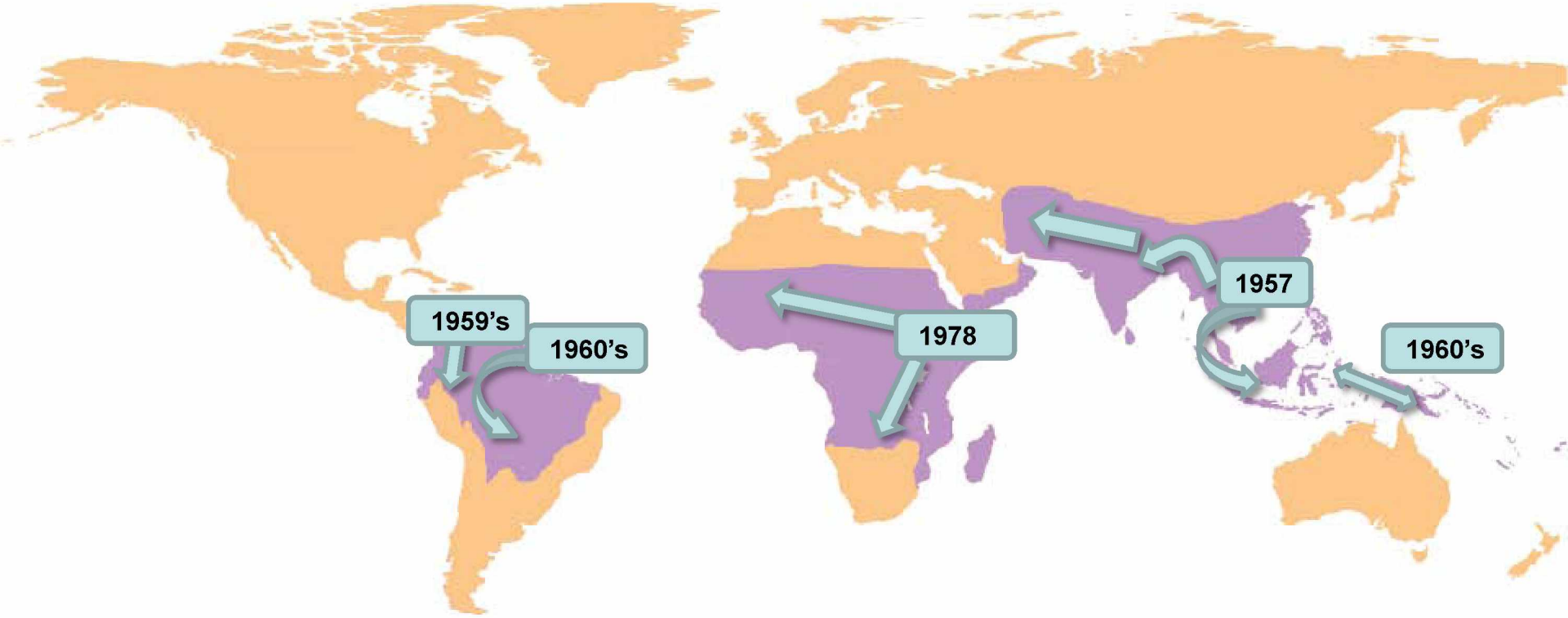
Worsening of Malaria Control (1990s)

- Decreased funding
- Intensification and spread of chloroquine resistance



Renewed Optimism in the New Millennium

- New partnerships
- New funding
- New political leadership in endemic countries
- New tools (drugs, bed nets)

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A COMMITMENT TO MALARIA CONTROL AND PREVENTION: THE FIRST STEPS TOWARDS ELIMINATION

John R. MacArthur, MD, MPH
Chief, Program Implementation Unit
Division of Parasitic Diseases and Malaria
Center for Global Health
Centers for Disease Control and Prevention

Overview

- **Roll Back Malaria and U.N. Millennium Development Goals**
- **President's Malaria Initiative (PMI)**
  - PMI under two presidents
  - Goals, targets, and funding
  - Focused interventions
  - CDC's role in PMI: Strategic information
- **Results achieved**
  - Significant reductions in malaria transmission

Roll Back Malaria (RBM)

- **Global partnership**
  - Launched in 1998
  - WHO, UNICEF, UNDP, World Bank
- **Global framework**
  - Coordination of activities
  - Mobilization of resources
  - Establishment of technical working groups
  - Establishment of subregional networks
- **Global Malaria Action Plan**
  - Launched September 25, 2008, by RBM partnership
  - Scaling up for impact
  - Sustaining control over time

www.rollbackmalaria.org
UNICEF, United Nations Children's Fund
UNDP, United Nations Development Program

United Nations Millennium Development Goals (MDG)

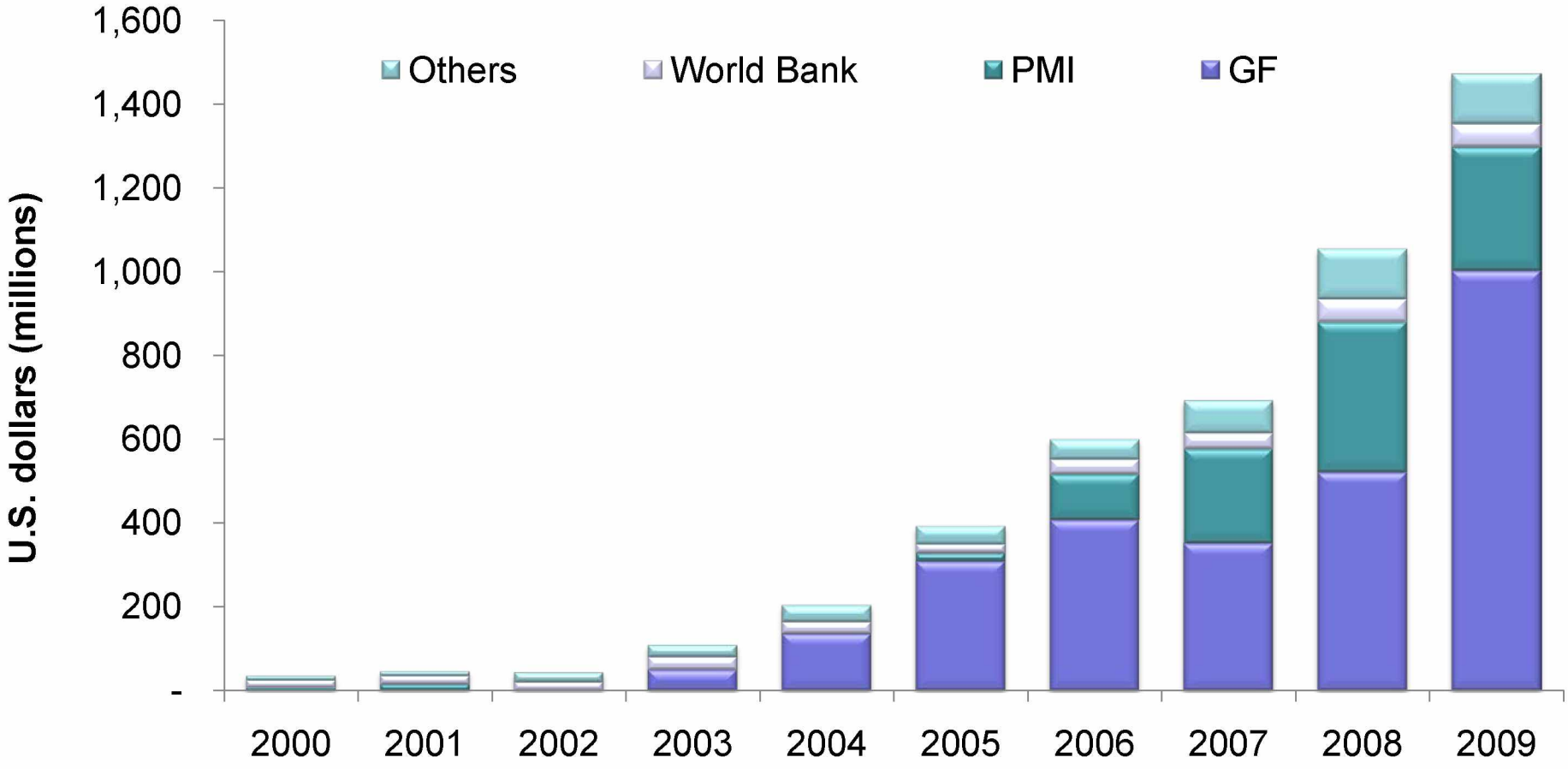
www.un.org/millenniumgoals

- **Goal 4: Reduce child mortality**
- **Goal 5: Improve maternal health**
- **Goal 6: Combat HIV/AIDS, malaria, and other diseases**
  - Target 6c: Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases
    - Incidence and death rates associated with malaria
    - Children under 5 sleeping under insecticide-treated bednets
    - Children under 5 with fever who are treated with appropriate anti-malarial drugs

WE CAN END POVERTY 2015 MILLENNIUM DEVELOPMENT GOALS

A Gateway to the UN System's Work on the MDGs

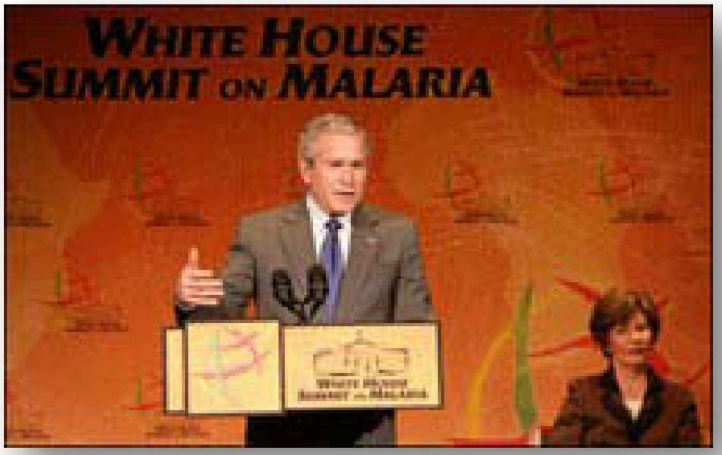
International Financial Disbursements to Malaria Endemic



Source: Malaria funding and resource utilization: the first decade of Roll Back Malaria. http://www.rbm.who.int/ProgressImpactSeries/docs/RBMMalariaFinancingReport-en.pdf
PMI, President's Malaria Initiative
GF, Global Fund

President's Malaria Initiative (PMI)

- **On June 30, 2005, President Bush announced a new initiative to rapidly scale up malaria control interventions in high-burden countries in Africa**
  - 5-year and $1.2B investment
- **Challenged other donors to increase their funding**



- **PMI is led by USAID and co-implemented with CDC**

Source: S. Craighead/White House (12/14/06)

PMI Goal and Targets

- Goal: Reduce malaria-related mortality by 50% in 15 selected countries
- Targets: Achieve 85% coverage of vulnerable groups with 4 key interventions (~270 million residents)

PMI Interv

Artemisinin-based combination therapies (ACTs)

Indoor residual spraying (IRS) (where appropriate)

ventions

Insecticide-treated bed nets (ITNs)

Intermittent preventive treatment in pregnancy (IPTp)

PMI Funding Levels and Coverage

Year	Funding Level	No. Countries Covered
2006	$30 M	3
2007	$135 M	7
2008	$300 M	15
2009	$300 M	15
2010	$500 M	15
TOTAL	$1,265 M	

PMI and the Global Health Initiative (GHI)

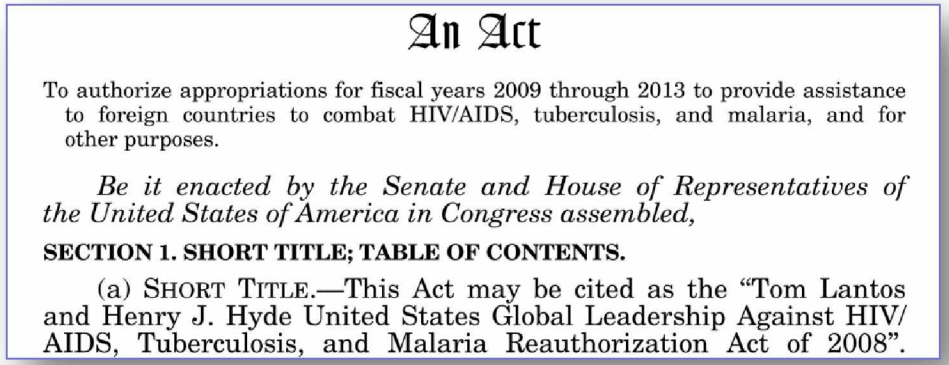
- **President Obama signals support for global health including malaria (September 2008)**
- **The White House launches Global Health Initiative**
  - U.S. Government will invest $63 billion over 6 years
- **PMI is now a major component of GHI**

"We will not be successful in our efforts to end deaths from AIDS, malaria, and tuberculosis unless we do more to improve health systems around the world, focus our efforts on child and maternal health, and ensure that best practices drive the funding for these programs."

—President Barack Obama, May 5, 2009

CDC's Mandate in PMI: Strategic Information

- **U.S. Congress (through the Lantos-Hyde Act, 2008) charged CDC to take a leading role in strategic information**
  - Monitoring and evaluation
  - Surveillance
  - Operations research



An Act

To authorize appropriations for fiscal years 2009 through 2013 to provide assistance to foreign countries to combat HIV/AIDS, tuberculosis, and malaria, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

SECTION 1. SHORT TITLE; TABLE OF CONTENTS.

(a) SHORT TITLE.—This Act may be cited as the "Tom Lantos and Henry J. Hyde United States Global Leadership Against HIV/AIDS, Tuberculosis, and Malaria Reauthorization Act of 2008".

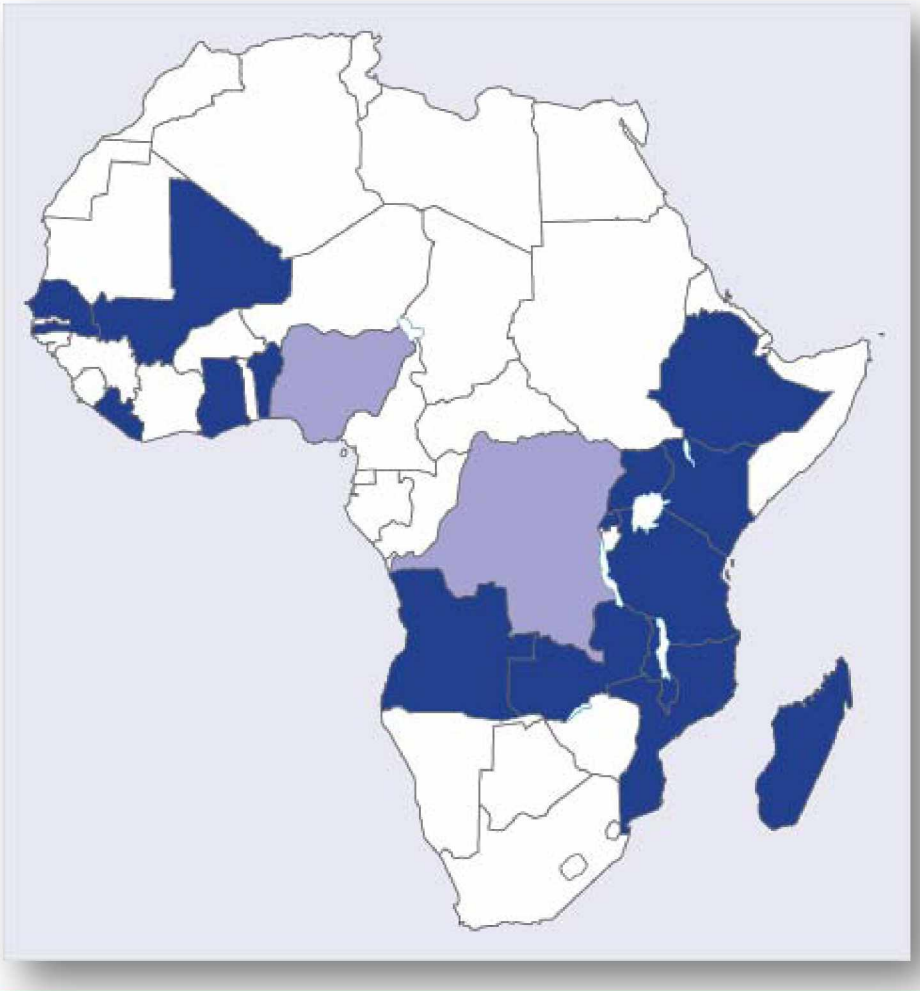
- **CDC is advising the U.S. Malaria Coordinator on priorities for these activities and being a key implementer**

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=110_cong_bills&docid=f:h5501enr.pdf

PMI Focus: 15 African Countries

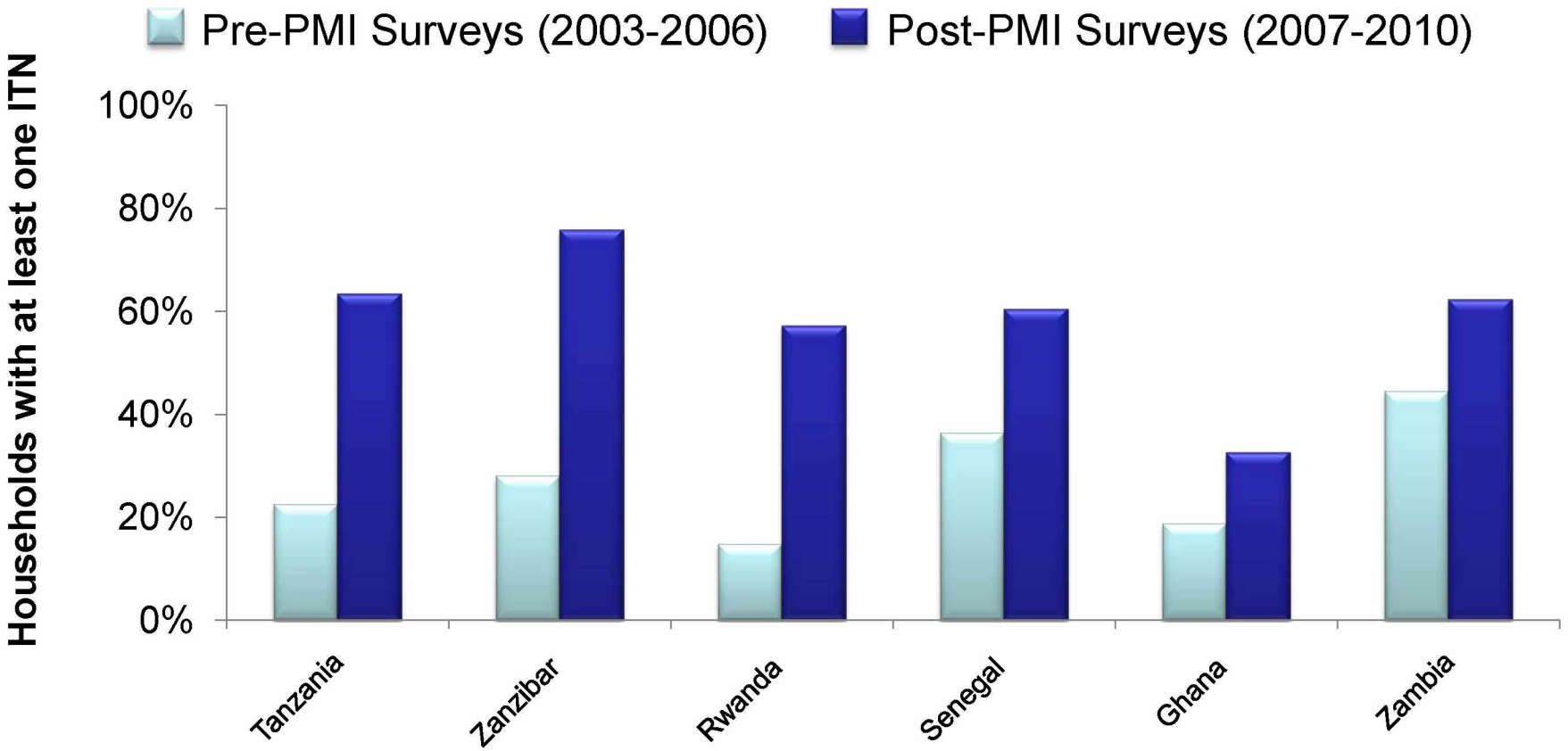
Angola
Benin
Ethiopia
Ghana
Kenya
Liberia
Madagascar
Malawi
Mali
Mozambique
Rwanda
Senegal
Tanzania
Uganda
Zambia

PMI Focus: Additional African Countries



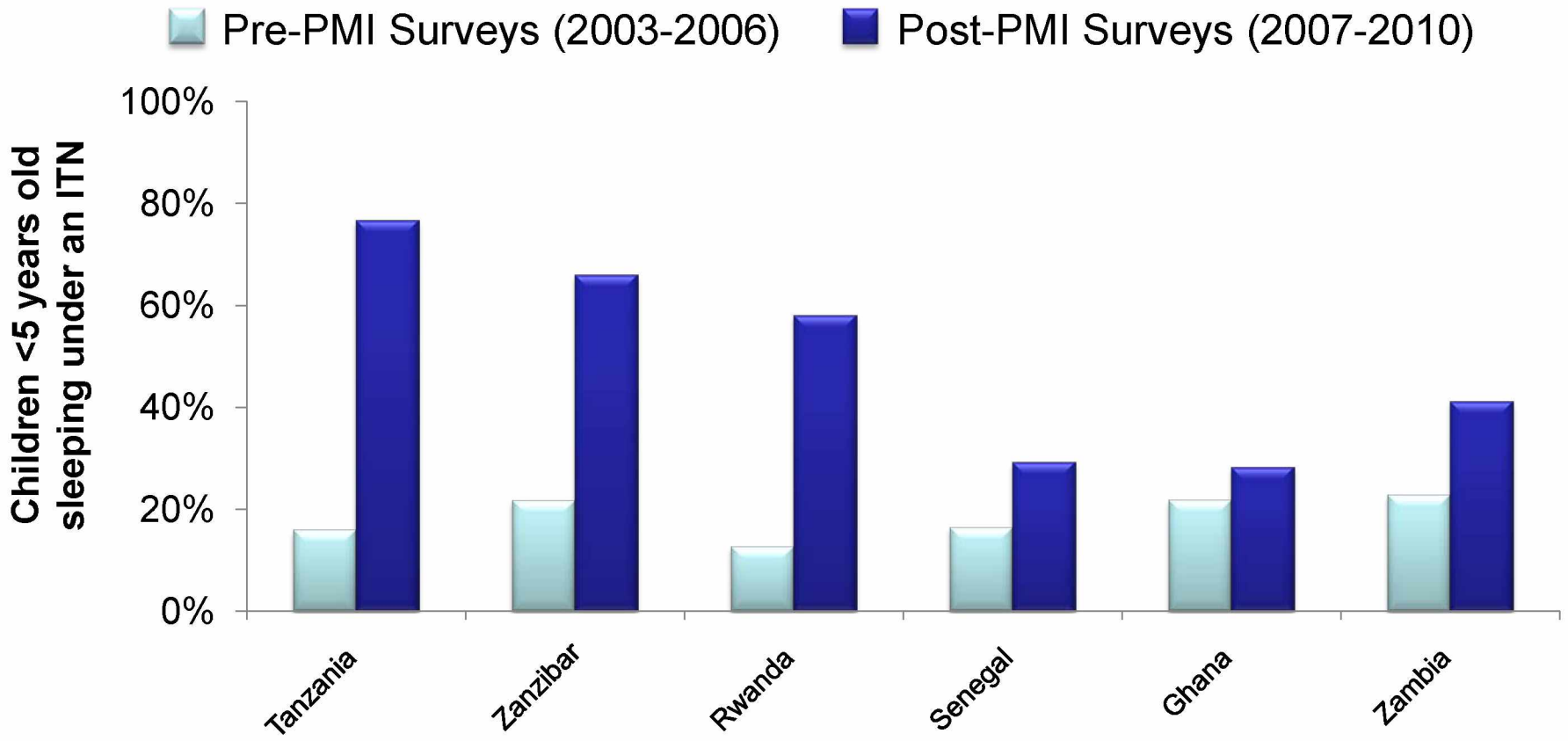
Nigeria and
the Democratic Republic of Congo
account for the 23%
of the world's burden
of the falciparum malaria

Proportion of Households with at Least 1 Insecticide-Treated Bed Net (ITN) from 2 Survey Points



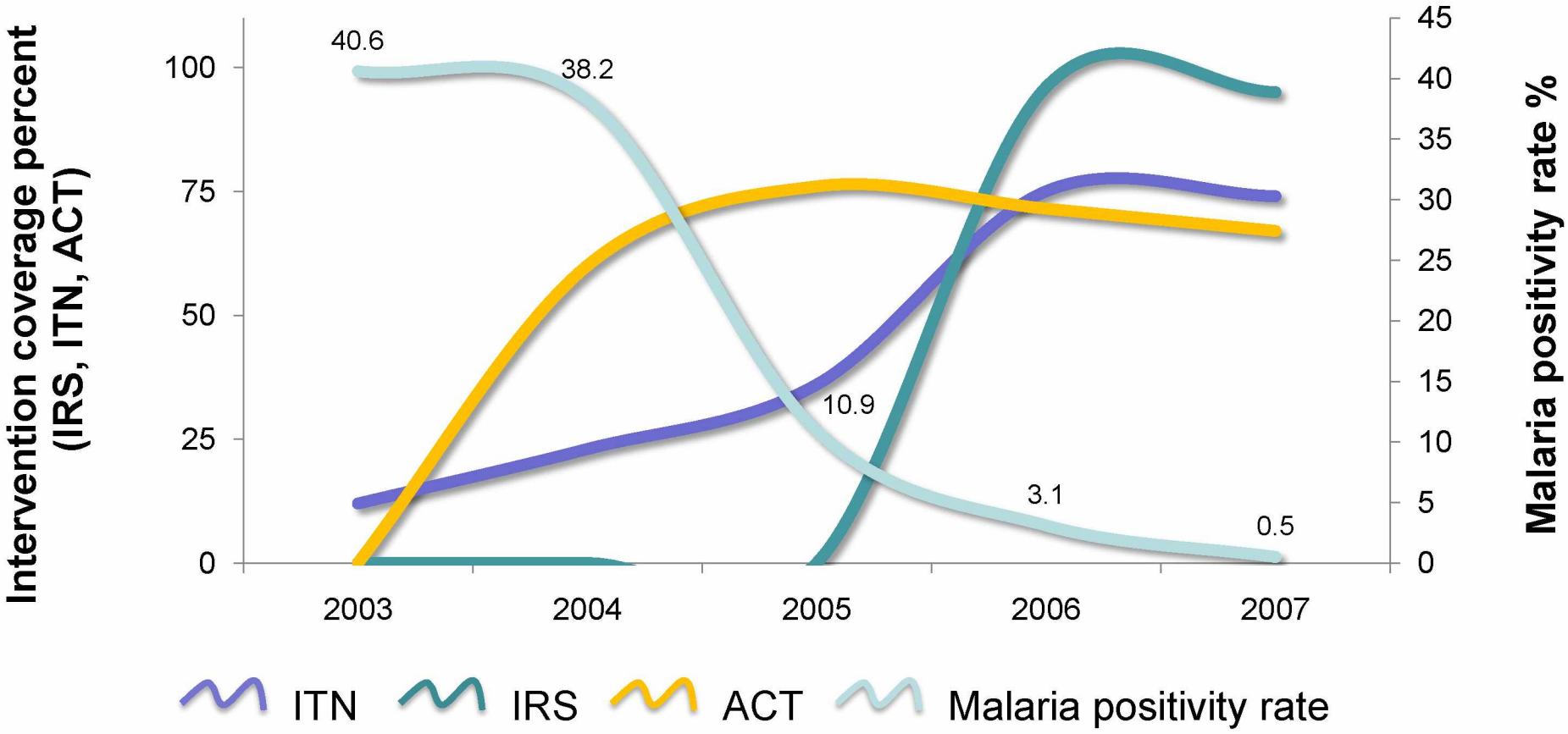
Data source: Demographic Health Survey, http://www.measuredhs.coom

Proportion of Children Aged <5 Years Who Slept Under an ITN the Previous Night



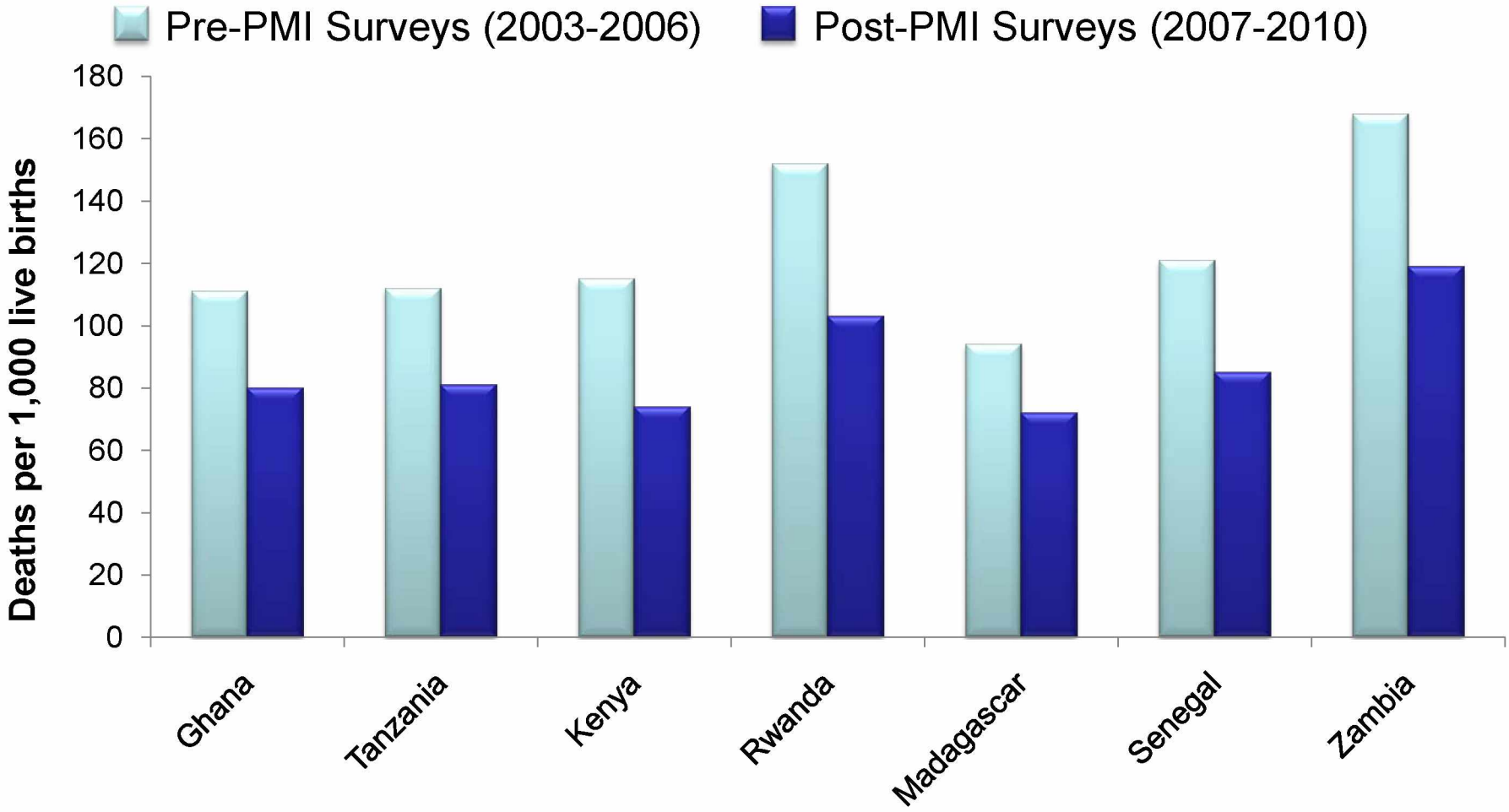
Data source: Demographic Health Survey, http://www.measuredhs.coom

Zanzibar: Intervention Coverage and Malaria control



ITN, Insecticide-treated bed net
IRS, Indoor residual spraying
ACT, Artemisinin-based combination therapy

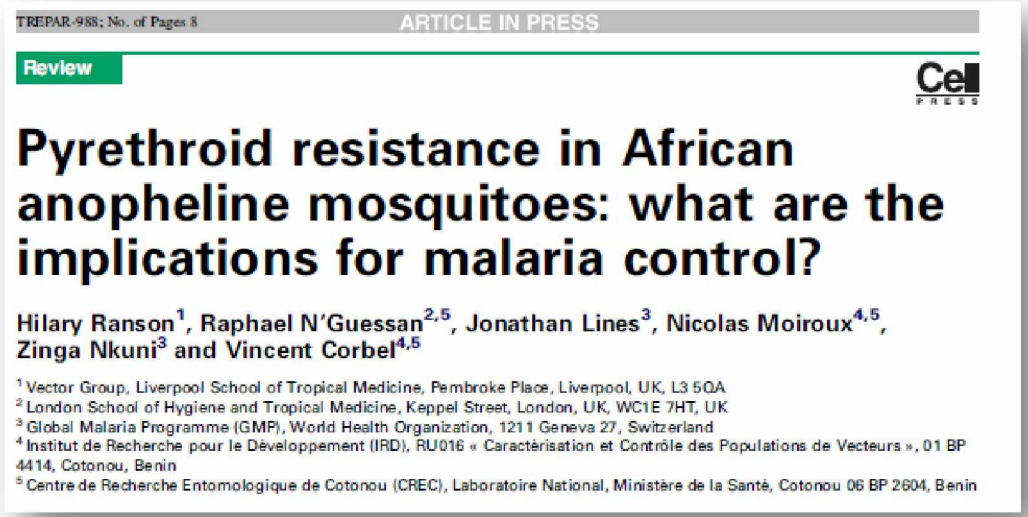
Declines in All-Cause Mortality in Children Aged <5 Years, 7 PMI Countries, 2003–2010



Data source: Demographic Health Survey, http://www.measuredhs.coom

Resistance – A Lurking Threat

- Emergence of insecticide resistance in Africa
  - DDT, pyrethroids
- Emergence of artemisinin resistance in Southeast Asia
  - Thai-Cambodia border



TREPAR-988; No. of Pages 8 ARTICLE IN PRESS

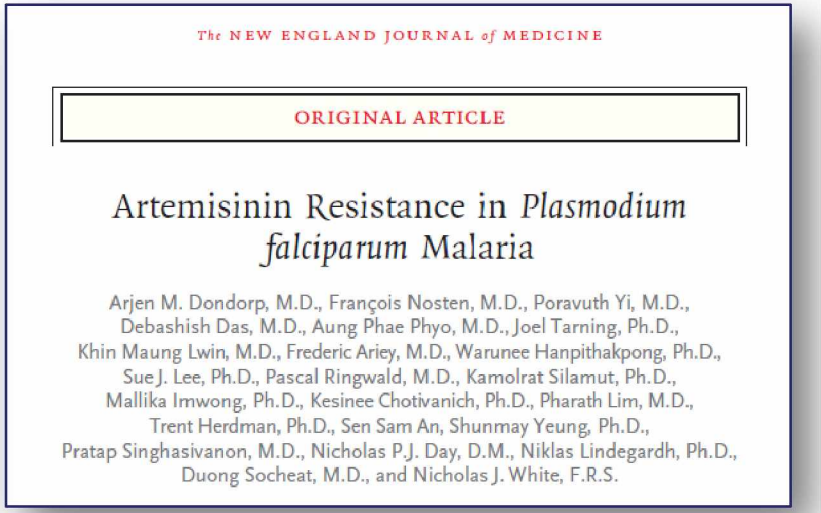
Review

Cell PRESS

Pyrethroid resistance in African anopheline mosquitoes: what are the implications for malaria control?

Hilary Ranson[1], Raphael N'Guessan[2,5], Jonathan Lines[3], Nicolas Moiroux[4,5], Zinga Nkuni[3] and Vincent Corbel[4,5]

[1] Vector Group, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, UK, L3 5QA
[2] London School of Hygiene and Tropical Medicine, Keppel Street, London, UK, WC1E 7HT, UK
[3] Global Malaria Programme (GMP), World Health Organization, 1211 Geneva 27, Switzerland
[4] Institut de Recherche pour le Développement (IRD), RU016 « Caractérisation et Contrôle des Populations de Vecteurs », 01 BP 4414, Cotonou, Benin
[5] Centre de Recherche Entomologique de Cotonou (CREC), Laboratoire National, Ministère de la Santé, Cotonou 06 BP 2604, Benin



The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Artemisinin Resistance in *Plasmodium falciparum* Malaria

Arjen M. Dondorp, M.D., François Nosten, M.D., Poravuth Yi, M.D., Debashish Das, M.D., Aung Phae Phyo, M.D., Joel Tarning, Ph.D., Khin Maung Lwin, M.D., Frederic Ariey, M.D., Warunee Hanpithakpong, Ph.D., Sue J. Lee, Ph.D., Pascal Ringwald, M.D., Kamolrat Silamut, Ph.D., Mallika Imwong, Ph.D., Kesinee Chotivanich, Ph.D., Pharath Lim, M.D., Trent Herdman, Ph.D., Sen Sam An, Shunmay Yeung, Ph.D., Pratap Singhasivanon, M.D., Nicholas P.J. Day, D.M., Niklas Lindegardh, Ph.D., Duong Socheat, M.D., and Nicholas J. White, F.R.S.

DDT, Dichlorodiphenyltrichloroethane

Summary: Results Achieved

- **Significant reductions in all-cause mortality**
  - Tanzania 19%
  - Madagascar 22%
  - Ghana 28%
  - Zambia 29%
  - Senegal 30%
  - Rwanda 32%
  - Kenya 36%
- **Massive scale-up of control interventions has been followed by substantial decreases in all-cause mortality in children aged <5 years**
- **Initiative-wide impact assessment is under way**

CDC's SCIENTIFIC EVIDENCE BASE FOR SCALE-UP AND POSITIONING FOR MALARIA ELIMINATION

S. Patrick Kachur, MD, MPH
Chief, Strategic and Applied Sciences Unit
Division of Parasitic Diseases and Malaria
Center for Global Health
Centers for Disease Control and Prevention

Overview

1. Scientific evidence: Basis for current interventions
2. Global Malaria Eradication Research Agenda
3. CDC operational research priorities, 2010

1. Scientific Evidence: Basis for Current Malaria Interventions

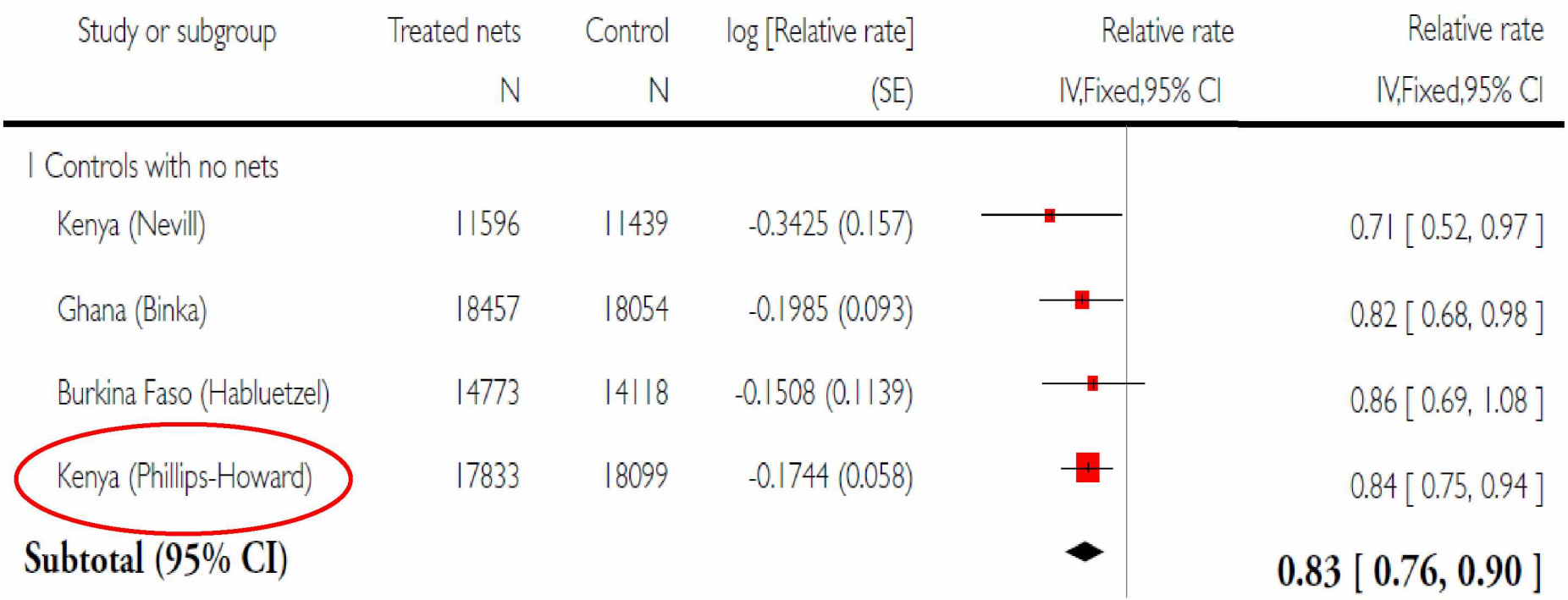
Artemisinin-based combination therapies (ACTs)

Insecticide-treated bed nets (ITNs)

Indoor residual spraying (IRS) (where appropriate)

Intermittent preventive treatment in pregnancy (IPTp)

Efficacy of ITNs on All-Cause Child Mortality from 4 Randomized Controlled Trials in Africa



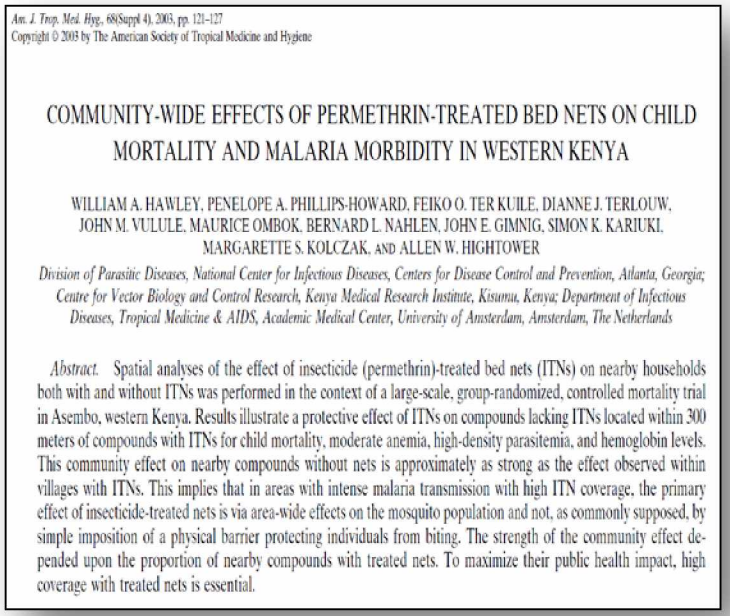
17% protective efficacy against child mortality before age of 5 years
Could save 5.5 lives for every 1,000 children protected

ITN, Insecticide-treated bed net

C Lengeler. Insecticide-treated bed nets and curtains for preventing malaria. Cochrane Database of Systematic Reviews 2004, Issue 2.

Additional Lessons from the KEMRI/CDC ITN Trial and Follow-up Studies

- **People without nets experienced the same benefit if they lived within 300 meters of net users – reduction in**
  - Parasite infection (odds ratio=0.59)
  - Malaria illness (odds ratio=0.52)
  - Anemia (odds ratio=0.53)
  - Child mortality (hazard ratio=0.72)



Am. J. Trop. Med. Hyg., 68(Suppl 4), 2003, pp. 121–127

COMMUNITY-WIDE EFFECTS OF PERMETHRIN-TREATED BED NETS ON CHILD MORTALITY AND MALARIA MORBIDITY IN WESTERN KENYA

WILLIAM A. HAWLEY, PENELOPE A. PHILLIPS-HOWARD, FEIKO O. TER KUILE, DIANNE J. TERLOUW, JOHN M. VULULE, MAURICE OMBOK, BERNARD L. NAHLEN, JOHN E. GIMNIG, SIMON K. KARIUKI, MARGARETTE S. KOLCZAK, AND ALLEN W. HIGHTOWER

Division of Parasitic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia; Centre for Vector Biology and Control Research, Kenya Medical Research Institute, Kisumu, Kenya; Department of Infectious Diseases, Tropical Medicine & AIDS, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

Abstract. Spatial analyses of the effect of insecticide (permethrin)-treated bed nets (ITNs) on nearby households both with and without ITNs was performed in the context of a large-scale, group-randomized, controlled mortality trial in Asembo, western Kenya. Results illustrate a protective effect of ITNs on compounds lacking ITNs located within 300 meters of compounds with ITNs for child mortality, moderate anemia, high-density parasitemia, and hemoglobin levels. This community effect on nearby compounds without nets is approximately as strong as the effect observed within villages with ITNs. This implies that in areas with intense malaria transmission with high ITN coverage, the primary effect of insecticide-treated nets is via area-wide effects on the mosquito population and not, as commonly supposed, by simple imposition of a physical barrier protecting individuals from biting. The strength of the community effect depended upon the proportion of nearby compounds with treated nets. To maximize their public health impact, high coverage with treated nets is essential.

KEMRI, Kenya Medical Research Institute
ITN, Insecticide-treated bed net
Hawley et al. Community-wide effects of permethrin-treated bed nets on child mortality and malaria morbidity in western Kenya. Am J Trop Med Hyg 2003;68(s4):121-7.

Additional Lessons from the KEMRI/CDC ITN Trial and Follow-up Studies

- **Survival benefit lasted beyond 6 years**
- **Mortality rates**
  - Infants: 113/1,000
  - Children 1–5 years old: 28/1,000

Sustainability of Reductions in Malaria Transmission and Infant Mortality in Western Kenya With Use of Insecticide-Treated Bednets

4 to 6 Years of Follow-up

Kim A. Lindblade, PhD
Thomas P. Eisele, PhD
John E. Gimnig, PhD
Jane A. Alaii, PhD
Frank Odhiambo, MPH
Feiko O. ter Kuile, MD, PhD
William A. Hawley, PhD
Kathleen A. Wannemuehler, MS
Penelope A. Phillips-Howard, PhD
Daniel H. Rosen, PhD
Bernard L. Nahlen, MD
Dianne J. Terlouw, MD, PhD
Kubaje Adazu, PhD
John M. Vulule, PhD
Laurence Slutsker, MD, MPH

Context Insecticide-treated bednets reduce malaria transmission and child morbidity and mortality in short-term trials, but this impact may not be sustainable. Previous investigators have suggested that bednet use might paradoxically increase mortality in older children through delayed acquisition of immunity to malaria.

Objectives To determine whether adherence to and public health benefits of insecticide-treated bednets can be sustained over time and whether bednet use during infancy increases all-cause mortality rates in older children in an area of intense perennial malaria transmission.

Design and Setting A community randomized controlled trial in western Kenya (phase 1: January 1997 to February 2000) followed by continued surveillance of adherence, entomologic parameters, morbidity indicators, and all-cause mortality (phase 2: April 1999 to February 2002), and extended demographic monitoring (January to December 2002).

Participants A total of 130 000 residents of 221 villages in Asembo and Gem were randomized to receive insecticide-treated bednets at the start of phase 1 (111 villages) or phase 2 (110 villages).

Main Outcome Measures Proportion of children younger than 5 years using insecticide-treated bednets, mean number of *Anopheles* mosquitoes per house, and all-cause mortality rates.

Results Adherence to bednet use in children younger than 5 years increased from 65.9%

JAMA. 2004;291:2571-2580 www.jama.com

Nations Development Program, the United Nations Children's Fund, and the World Bank, aims to halve malaria mortality by 2010 through implementation of 4 key technical strategies: insecticide-treated bednets, improved case

See also Patient Page.

Author Affiliations: Division of Parasitic Diseases, Centers for Disease Control and Prevention, Atlanta, Ga (Drs Lindblade, Gimnig, ter Kuile, Hawley, Phillips-Howard, Rosen, Nahlen, Terlouw, and Slutsker, and Ms Wannemuehler); Department of International Health and Development, Tulane School of Public Health and Tropical Medicine, New Orleans, La (Dr Eisele); Centre for Vector Biology and Control Research, Kenya Medical Research Institute, Kisumu (Drs Alaii and Vulule, and Mr Odhiambo); and CDC/Kenya, Kenya Medical Research Institute, Nairobi (Dr Adazu). Drs ter Kuile and Terlouw are now with Liverpool School of Tropical Medicine, Liverpool, England. Dr Nahlen is now with Roll Back Malaria, World Health Organization, Geneva, Switzerland.

Corresponding Author: Kim A. Lindblade, PhD, Division of Parasitic Diseases, Centers for Disease Control and Prevention, 4770 Buford Hwy, MS F-22, Atlanta, GA 30333 (klindblade@kisian.mimcom.net).

KEMRI, Kenya Medical Research Institute
ITN, Insecticide-treated bed net
Lindblade et al. Sustainability of reductions in malaria transmission and infant mortality in western Kenya with use of insecticide-treated bed nets: 4-6 years of follow-up. JAMA 2004;291(21):2571-80.

Additional Lessons from the KEMRI/ CDC ITN Trial and Follow-up Studies

- **Providing nets to 65% of older children and adults would protect even children without nets**

Adam Nadel, Freelance

OPEN ACCESS Freely available online PLoS MEDICINE

Preventing Childhood Malaria in Africa by Protecting Adults from Mosquitoes with Insecticide-Treated Nets

Gerry F. Killeen[1,2*], Tom A. Smith[3], Heather M. Ferguson[1,4,5], Hassan Mshinda[1], Salim Abdulla[1], Christian Lengeler[3], Steven P. Kachur[1,6]

1 Ifakara Health Research and Development Centre, Ifakara, Morogoro, United Republic of Tanzania, 2 Department of Biological and Biomedical Sciences, University of Durham, Durham, United Kingdom, 3 Department of Public Health and Epidemiology, Swiss Tropical Institute, Basel, Switzerland, 4 Division of Infection and Immunity, Glasgow University, Glasgow, United Kingdom, 5 Division of Environmental and Evolutionary Biology, Glasgow University, Glasgow, United Kingdom, 6 United States Public Health Service Commissioned Corps and Malaria Branch, Division of Parasitic Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America

KEMRI, Kenya Medical Research Institute
ITN, Insecticide-treated mosquito net
Killeen et al. Preventing childhood malaria in Africa by protecting adults from mosquitoes with insecticide-treated nets. PLoS Medicine 2008;4(7):e229.

Policy Impact of the KEMRI/ CDC ITN Trial and Follow-up Studies

Established the evidence-base for widespread scale-up and universal coverage

FROM EVIDENCE TO POLICY

Continued progress in scale-up and elimination will require improved tools for malaria control and surveillance

- **Scale-up: Aims to reduce morbidity and mortality**
- **Elimination: Aims to reduce transmission**
  - **Basic reproduction number <1.0**

G MacDonald (1957). The epidemiology and control of malaria. Oxford University Press: London.

2. Global Malaria Eradication Research Agenda

- **New tools and systems to accommodate**
  - Drugs
  - Vaccines
  - Diagnostics
  - Insecticides
- **Strategies to manage resistance to antimalarial drugs and insecticides for public health**
  - Combination treatments
  - Combined delivery systems
  - Rotational or mosaic deployment

Global Malaria Eradication Research Agenda

- **Alternative vector interventions**
  - ITNs and spraying work against mosquitoes indoors
  - Some mosquitoes feed and rest outdoors
    - Larviciding
    - Spatial repellants, baited traps
- **Drug interventions for reducing transmission**
  - Mass screen and treatment
  - Transmission-blocking agents
- **Surveillance: Detecting and responding to local transmission**

ITN, Insecticide-treated bed net

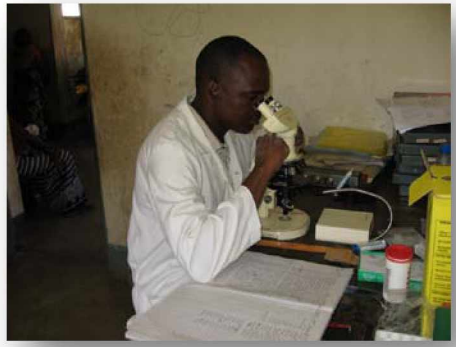
3. CDC Operational Research Priorities in 2010

From Scale-up To Elimination

- **Optimize current malaria control interventions**
- **Establish role for new and revisited interventions**
  - Research and development
  - Clinical and field trials of new interventions
- **Integration with other initiatives**

Research and Development: Field-Ready, High-Sensitivity Test for Malaria

- **WHO now calls for universal access to malaria diagnosis and treatment for every case of suspected malaria**
- **Diagnostic confirmation**
  - Minimize the overuse of treatments
  - Improves detection and treatment of other causes of illness
  - Forms the basis of a reliable system for monitoring malaria and malaria control

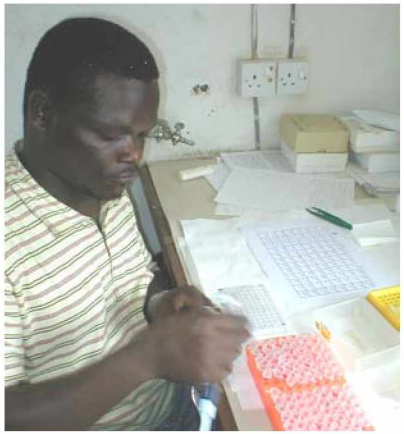


Light microscopy

Rapid antigen detection

Research and Development: Field-Ready, High-Sensitivity Test for Malaria

- **As endemic countries approach elimination, highly sensitive tests become more critical**
- **Current diagnostic formats will improve management of malaria illness**
- **Elimination may rest on molecular assays**
  - Available only in reference laboratories far from remote areas

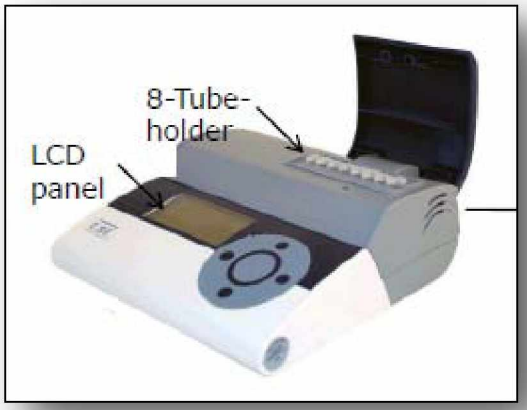


Molecular assays

Research and Development: Field-Ready, High-Sensitivity Test for Malaria

- **CDC and University of Georgia**
- **Novel system for molecular diagnosis**
- **Real-time fluorescence loop-mediated amplification: Real LAMP**
  - Detection of malaria parasites at very low numbers
  - Without access to reference laboratory staffing and equipment
  - Validation of the first generation prototype on specimens from Tanzania completed

Real-LAMP



N Lucchi, *et al*. (2010). Point of Care Diagnosis for Malaria by Fluorescence Loop-Mediated Isothermal Amplification. PLoS Medicine; in press.

Clinical and Field Trials of New Interventions

- **Phase III malaria vaccine trial in Kenya**
  - First candidate vaccine to reach this stage of development
  - One of 11 sites in 9 countries
  - Could reduce clinical malaria by up to 35%, severe malaria by 49%

PL Alonso, *et al.* (2004). Efficacy of the RTS,S/AS02A vaccine against *Plasmodium falciparum* infection and disease in young African children: randomised controlled trial. *Lancet* 364(9443):1411-20.

Clinical and Field Trials of New Interventions

- **When will we have a vaccine that can eliminate malaria?**
  - Current vaccine within 18–24 months
  - Will reduce illness burden, not transmission
  - Hundreds of other candidates in development
  - Millennia of co-evolution confound development

Clinical and Field Trials of New Interventions

- **Combined impact of ITNs with indoor residual spraying**
  - Western Kenya (2008–2010)
  - Northern Ghana (starting 2011)

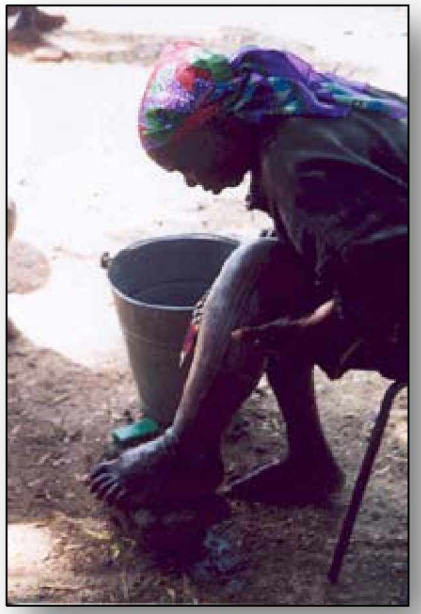
- **Combined impact of ITNs with insecticide-treated durable wall liners**
  - Lakeside Malawi (starting 2011)

ITN , Insecticide-treated bed net

Integration Opportunities

From Scale-up To Elimination

- Community-based control/ elimination
- Integrated case management interventions
- Integrated vector control
- Integrated surveillance, monitoring and evaluation



From Scale-Up to Elimination: the Role of Partnership

- **Creative partnerships within the U.S. government**
  - Within Department of Health and Human Services
  - With U.S. government partners
- **Partnerships beyond our system**

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