The President's Malaria Initiative

Eleventh Annual Report to Congress
April 2017

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Abbreviations and Acronyms

ACT	Artemisinin-based combination therapy
ANC	Antenatal care
AQ+SP	Amodiaquine plus sulfadoxine-pyrimethamine
BVBD	Bureau of Vector Borne Diseases
CDC	U.S. Centers for Disease Control and Prevention
CHW	Community health worker
DFID	U.K. Department for International Development
DHIS-2	District Health Information System – Version 2
DHS	Demographic and Health Survey
DRC	Democratic Republic of the Congo
ECAMM	External competency assessment for malaria microscopists
EDS	Electronic data system
eLMIS	Electronic logistics management information system
EUV	End-use verification tool
FELTP	Field Epidemiology and Laboratory Training Program
FY	Fiscal year
G6PD	Glucose 6 phosphate dehydrogenase
GHSA	Global Health Security Agenda
Global Fund	The Global Fund to Fight AIDS, Tuberculosis and Malaria
GMS	Greater Mekong Subregion
GTS	Global Technical Strategy
HMIS	Health management information system
I2I	Innovation to Impact
iCCM	Integrated community case management
IPTp	Intermittent preventive treatment for pregnant women
IRS	Indoor residual spraying
ISO	International Organization for Standardization
ITN	Insecticide-treated mosquito net
MIS	Malaria Indicator Survey
MAD	*Make a Difference*
M&E	Monitoring and evaluation
MIP	Malaria in pregnancy
MIS	Malaria Indicator Survey
MMV	Medicines for Malaria Venture
NAMS	National archive of malaria slides
NIH	National Institutes of Health
NMCP	National malaria control program
OTSS	Outreach training and supportive supervision
PMI	U.S. President's Malaria Initiative
ProAct	Proactive community treatment
QA	Quality assurance
RBM	Roll Back Malaria
RDT	Rapid diagnostic test
SBCC	Social behavior change communication
SLIS	*Système Local d'Information Sanitaire*
SMC	Seasonal malaria chemoprevention
SP	Sulfadoxine-pyrimethamine
TES	Therapeutic efficacy surveillance
UNICEF	United Nations Children's Fund
USAID	U.S. Agency for International Development
WHO	World Health Organization

Riccardo Gangale, VectorWorks, Courtesy of Photoshare

Executive Summary

MALARIA'S TOLL

Malaria remains a fact of life for billions of people living in tropical areas. Each year, malaria kills an estimated 429,000 people worldwide.[1] In sub-Saharan Africa, infection with malaria parasites also makes young children more likely to die of pneumonia and diarrhea. Because malaria is one of the main reasons that children miss school and adults miss work, it is a disease that further hampers educational achievement, contributes to food insecurity, and entrenches poverty.

U.S. GOVERNMENT CONTRIBUTIONS TO HISTORIC PROGRESS AGAINST MALARIA

While malaria can be deadly, it is also a preventable and curable disease. Global progress in the fight against malaria since 2000 has been truly historic, and the U.S. Government has played a key role in this achievement. The World Health Organization (WHO) estimates that more than 6.8 million malaria deaths were averted worldwide between 2001 and 2015, primarily among children under five years of age in sub-Saharan Africa.[2] The greatest progress occurred after 2005, when U.S. President's Malaria Initiative (PMI) programs were operational and making contributions alongside partner countries and other donors to malaria control efforts. The Millennium Development Goal target of halting and reversing malaria incidence by 2015 was attained and surpassed. As a result of these unprecedented successes, the global malaria community has embraced a long-term goal of malaria eradication.[3] PMI's Strategy for 2015–2020 supports this global vision of a world without malaria (see Box, page 7).

The U.S. Government has shown unwavering commitment to ending the scourge of malaria, especially since the launch of PMI in 2005. The Initiative operates in 19 of the highest burden countries across sub-Saharan Africa, as well as 2 countries and a regional program in the Greater Mekong Subregion (GMS). In FY 2016, PMI reached more than 480 million people at risk of malaria across sub-Saharan Africa. The Initiative, led by the U.S. Agency for International Development (USAID) and implemented together with the U.S. Centers for Disease Control and Prevention (CDC), has contributed to substantial reductions in malaria deaths and illness in partner countries. According to the 2015 World Malaria Report, between 2000 and 2015, global malaria mortality has declined by an estimated 48 percent and malaria incidence by 37 percent.

Furthermore, across the 19 PMI focus countries in sub-Saharan Africa, between 2010 and 2015:

- Malaria mortality rates decreased by 29 percent with 10 PMI focus countries achieving 20 percent to 40 percent reductions, and
- Malaria incidence decreased by 19 percent with 9 PMI focus countries achieving 20 percent to 40 percent reductions.

These reductions, which have been achieved on top of the recorded progress in PMI focus countries since the start of the Initiative, have contributed to the reported declines in all-cause child mortality. To date, 18 of the 19 PMI focus countries in Africa have data from paired nationwide surveys that were conducted since PMI activities began. All 18 countries have documented declines in all-cause mortality rates among children under five (see Figure 1, page 6).[4] The large-scale rollout of malaria prevention and treatment measures across sub-Saharan Africa during the past decade has been an important factor in these child survival improvements.

In addition to the reductions in malaria mortality, a number of PMI focus countries also have documented significant decreases in reported malaria cases. In some countries, the

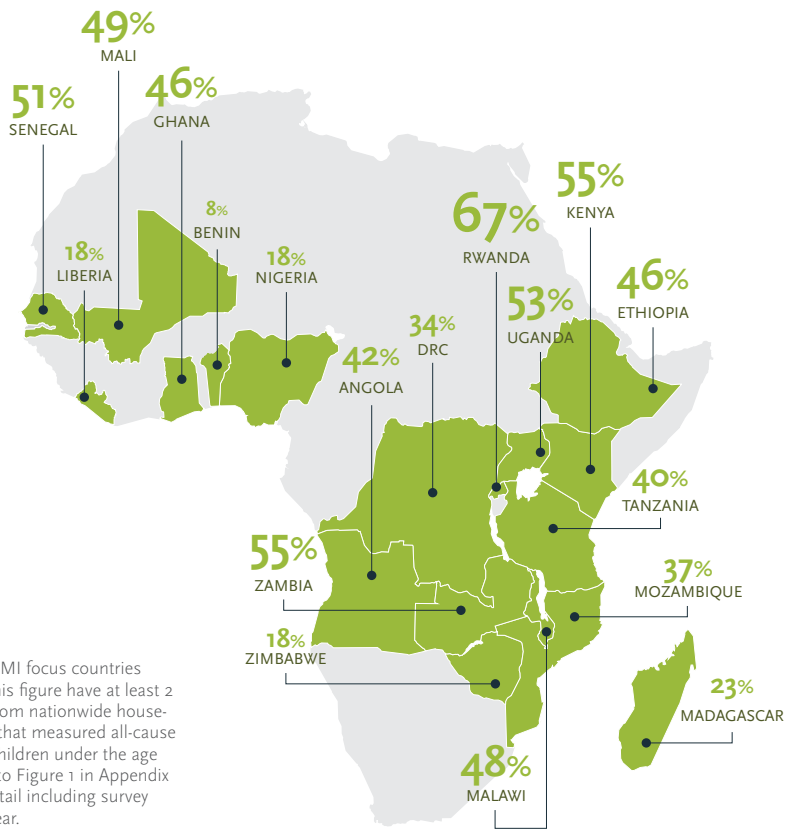
1 World Health Organization, 2016 World Malaria Report.

2 World Health Organization, 2016 World Malaria Report.

3 World Health Organization, 2015. Global Technical Strategy for Malaria, 2016–2030.

4 While reductions in all-cause child mortality may be the result of both malaria and non-malaria related child health interventions, PMI relies on this indicator to measure the impact of malaria control interventions in accordance with the recommendations of the Roll Back Malaria Monitoring and Evaluation Reference Group. All-cause child mortality captures both the direct and indirect effects of malaria.

Figure 1. Reductions in All-Cause Mortality Rates of Children Under Five Years of Age in PMI Focus Countries



Note: All 18 PMI focus countries included in this figure have at least 2 data points from nationwide household surveys that measured all-cause mortality in children under the age of five. Refer to Figure 1 in Appendix 3 for more detail including survey source and year.

drop in malaria cases has been large enough that these countries now have set their sights on eliminating malaria in the next 30 years. The leaders of all six countries in the GMS have committed to eliminating malaria by 2030. To date, eight PMI focus countries (**Burma, Cambodia, Ethiopia, Madagascar, Senegal, Thailand, Zambia,** and **Zimbabwe**) and Zanzibar in the Republic of **Tanzania** have both adopted national strategies that include an elimination goal and allocated resources in support of that goal.

After documenting significant decreases in malaria burden, a few PMI focus countries in sub-Saharan Africa have seen increases in reported malaria cases in the last few years, which are likely due to multiple factors including increased care seeking, improved case reporting, and in some cases, actual increases in malaria transmission. PMI is working with national governments and partners to verify these increases in reported cases, investigate the potential causes, and respond appropriately in those instances where increases in malaria burden are identified.

Nevertheless, the 2016 WHO World Malaria Report estimates that overall malaria incidence decreased by 21 percent globally between 2010 and 2015, and the proportion of the population at risk in sub-Saharan Africa who are infected with malaria parasites is estimated to have declined to 13 percent in 2015.

ACHIEVING AND SUSTAINING SCALE OF PROVEN INTERVENTIONS

Under the national leadership of PMI focus countries and in close collaboration with other donors, PMI's direct contributions to the scale-up of proven and effective malaria prevention and control tools have been substantive. These tools currently include insecticide-treated mosquito nets (ITNs), indoor residual spraying (IRS), intermittent preventive treatment for pregnant women (IPTp), seasonal malaria chemoprevention (SMC), and diagnosis by malaria microscopy or rapid diagnostic test (RDT), together with effective treatment for confirmed malaria cases with artemisinin-based combination therapies (ACTs).

As a result of PMI's support, millions of people have benefited from protective measures against

THE PRESIDENT'S MALARIA INITIATIVE STRATEGY FOR 2015–2020

The PMI Strategy for 2015–2020 takes into account the progress over the past decade and the new challenges that have arisen, setting forth a vision, goal, objectives, and strategic approach for PMI through 2020, while reaffirming the longer-term goal of a world without malaria. Malaria prevention and control remains a major U.S. foreign assistance objective, and this strategy fully aligns with the U.S. Government's vision of ending preventable child and maternal deaths and ending extreme poverty.

The U.S. Government shares the long-term vision of affected countries and global partners of a world without malaria. This vision will require sustained, long-term efforts to drive down malaria transmission and reduce malaria deaths and illnesses, leading to country-by-country elimination and eventual eradication by 2040–2050. The U.S. Government's goal under the PMI Strategy 2015–2020 is to work with PMI-supported countries and partners to further reduce malaria deaths and substantially decrease malaria morbidity, toward the long-term goal of elimination. Building upon the progress to date in PMI-supported countries, PMI will work with national malaria control programs and partners to accomplish the following objectives by 2020:

1. **Reduce malaria mortality by one-third from 2015 levels in PMI-supported countries, achieving a greater than 80 percent reduction from PMI's original 2000 baseline levels.**
2. **Reduce malaria morbidity in PMI-supported countries by 40 percent from 2015 levels.**
3. **Assist at least five PMI-supported countries to meet the WHO criteria for national or sub-national pre-elimination.**

To achieve these objectives, PMI will take a strategic approach that emphasizes the following five areas:

1. **Achieving and sustaining scale of proven interventions**
2. **Adapting to changing epidemiology and incorporating new tools**
3. **Improving countries' capacity to collect and use information**
4. **Mitigating risk against the current malaria control gains**
5. **Building capacity and health systems**

This strategic approach is informed by PMI's experiences to date. It builds on the successes that countries have achieved, incorporates the lessons learned from implementation thus far, and addresses the challenges that could hamper further progress toward malaria control and elimination.

malaria, and millions more have been diagnosed and treated for malaria. Furthermore, tens of thousands of people have been trained on case management, malaria diagnosis, preventive treatment for pregnant women, and IRS operations (see Appendix 2 for more details). Close collaboration and synergies with other partners engaged in malaria control efforts have also been a hallmark of PMI from the outset of the Initiative (see Box, page 12).

Since the Initiative began, nationwide household surveys in the 19 focus countries have documented significant improvements in the coverage of malaria control interventions such as:

- Household ownership of at least one ITN increased from a median of 36 percent to 68 percent.

- Usage of an ITN the night before the survey increased from a median of 22 percent to 52 percent among children under five years of age.

- Usage of an ITN the night before the survey increased from a median of 20 percent to 50 percent among pregnant women.

And, in all 17 focus countries where IPTp is national policy:

- The proportion of pregnant women who received 2 or more doses of IPTp for the prevention of malaria increased from a median of 14 percent to 37 percent.

In addition to supporting the rollout of ITNs and IPTp, PMI has been a global leader in supporting countries to implement IRS activities. The number of people protected through PMI-supported IRS was more than 16 million across 12 PMI focus countries in FY 2016.

Timely, accurate, and effective case management is also critical to effective malaria control. In all focus countries, PMI supports universal diagnostic testing to accurately identify patients with malaria and immediate treatment with an appropriate, quality-assured ACT for those who test positive. As a result of these efforts, the proportion of suspected malaria cases that are confirmed with laboratory tests and treated with a recommended antimalarial drug combination continues to increase in nearly all focus countries. Fifteen countries have reached more than 60 percent confirmation of malaria cases by diagnostic test, 10 of which exceed 80 percent confirmation.

ADAPTING TO CHANGING MALARIA EPIDEMIOLOGY AND INCOPORATING NEW TOOLS

With the scale-up of malaria control interventions and subsequent reductions in malaria mortality and morbidity, some PMI focus countries have adopted more targeted approaches to malaria control with strategies that focus control activities at the subnational level or target specific population groups. PMI is supporting countries as they roll out such targeted interventions and, where appropriate, supporting activities that aim to move countries closer to malaria elimination. PMI also is investing in testing the effectiveness and feasibility of new tools and approaches and supporting operational research to improve intervention scale-up and impact. For example, during FY 2016, PMI supported:

- Enhanced case finding and investigation activities in **Cambodia, Senegal,** and **Zanzibar**. As these countries move toward elimination, identifying, tracking, and following up every malaria case becomes an important tool to interrupt malaria transmission and identifying residual foci of transmission.

- Operational research to complement U.S. Government investments in upstream malaria research, which is carried out by CDC, USAID, the National Institutes of Health, and the Department of Defense. In line with PMI's Strategy for 2015–2020, PMI-funded operational research addresses bottlenecks in achieving and maintaining coverage of proven interventions, while also informing malaria control efforts as malaria epidemiology changes, risks and challenges arise or intensify, and new tools are introduced to combat them. PMI resources support those research questions that are important and relevant to achieving PMI's objectives. To date, PMI has funded 102 operational research studies and contributed to more than 200 peer-reviewed publications. In FY 2016, for example, PMI-supported operational research studies included:

  - A study investigating the acceptability of insecticide-treated clothing among rubber tappers in **Burma**, a group that is at high risk of malaria infection

  - A qualitative study assessing barriers to net use in **Madagascar**, which is informing the country's new social and behavior change communication strategy

IMPROVING COUNTRY CAPACITY TO COLLECT AND USE INFORMATION

PMI has prioritized collecting data to monitor confirmed malaria cases as well as the coverage and impact of key malaria interventions and supporting countries to use these data to guide program planning and implementation as well as to inform malaria-related policies. PMI provides support for a broad set of malaria data collection efforts across PMI focus countries. These include support for nationwide household surveys, routine health management systems, entomological monitoring, therapeutic efficacy monitoring, and supply chain related surveys of malaria commodities. For example:

- PMI is working closely with partner countries to support deployment of online platforms such as the District Health Information System-2 (DHIS-2) to improve data quality and improve the efficiency of data collection, analysis, and reporting from health management information systems (HMIS). To date, 16 of the 19 PMI focus countries in Africa have fully transitioned their HMIS system to the DHIS-2 platform or are in the process of transitioning.

- Since PMI's launch in 2005, 80 nationally representative household surveys have been conducted with PMI's support across the 19 focus countries in Africa. These surveys have provided essential information on the coverage of key interventions and all-cause child mortality.

- The capacity of countries to monitor entomological indicators has substantially improved with PMI's support, and all 19 PMI focus countries in Africa currently conduct regular entomological monitor-

ing. In seven countries, PMI has supported the rollout of entomological monitoring databases to compile entomology data to drive decision-making around vector control interventions.

- To monitor the availability of malaria commodities at health facilities and address stockouts, PMI has conducted more than 221 end-use verification surveys with government counterparts in a total of 16 PMI focus countries.

MITIGATING RISK AGAINST THE CURRENT MALARIA CONTROL GAINS

ITNs and IRS both rely on a limited number of WHO-recommended insecticides from only four insecticide classes, and only one class – pyrethroids – is currently available for use in ITNs. When countries expand their ITN and IRS programs, this places increased insecticide selection pressure on mosquito populations, which can accelerate the selection and spread of vector resistance to insecticides. It is, therefore, imperative that national malaria control programs (NMCPs) continue to conduct entomological monitoring, including testing for the presence of insecticide resistance. Across PMI focus countries, insecticide resistance is being measured at approximately 190 sites. Mosquito resistance to pyrethroids has now been detected in all 19 PMI focus countries in Africa, while resistance to carbamate insecticides has been found in 16 PMI focus countries. This has prompted changes in the insecticides used for IRS in the 12 PMI focus

IN FY 2016, PMI

Procured **+30M** long-lasting insecticide-treated nets

Sprayed **+4M** houses with insecticides, protecting **+16M** people

Trained **+25,000** people to implement IRS

Procured **+7M** intermittent preventive treatments for pregnant women

Trained **+38,000** health workers in IPTp delivery

Procured **+10M** seasonal malaria chemoprevention treatments for children, and helped protect **+1.2M** children from malaria

Procured **+44M** antimalarial treatments and **+77M** rapid diagnostic tests

Trained **+51,000** health workers in malaria case management and **+43,000** clinicians and laboratory technicians in procedures for quality diagnostic testing for malaria

Kenneth Assoude

countries that maintain spray programs. For example, in FY 2016, all PMI-supported IRS activities were conducted using a long-lasting organophosphate insecticide.

Despite the emergence of resistance to pyrethroids, ITNs continue to remain effective. The current global recommendation is to replace ITNs every 3 years. However, studies conducted by PMI have shown that ITNs may physically deteriorate more quickly under certain field conditions and that ITN longevity is strongly dependent on behavioral and environmental conditions. PMI has developed a standardized methodology for monitoring ITN durability. In FY 2016, PMI expanded durability monitoring activities to 14 countries, and additional countries are preparing for implementation in the coming year.

Although there is currently no evidence of artemisinin resistance outside of the GMS, carefully monitoring the efficacy of antimalarial drugs in sub-Saharan Africa is now even more critical to ensure prompt detection of and response to the emergence of artemisinin resistance in Africa, should it occur. During FY 2016, PMI continued to support a network of 41 therapeutic efficacy surveillance (TES) sites in the GMS to monitor first-line antimalarial drugs and potential alternatives. PMI has also incorporated monitoring for K13 mutations, a genetic marker for artemisinin resistance, and other molecular markers associated with resistance to partner drugs. In FY 2016, PMI has supported monitoring of K13 mutations in seven countries in Africa, none of which have exhibited markers associated with artemisinin resistance.

Fake and substandard malaria medicines continue to be a major global threat to effective malaria case management and are likely to contribute significantly to malaria deaths. As a major procurer of ACTs, PMI employs a stringent quality assurance and quality control strategy to monitor the quality of drugs procured by PMI. To help reduce the availability of counterfeit drugs in private sector outlets and marketplaces, PMI is collaborating with USAID's Office of Inspector General and teaming up with local police, customs agents, national medicines regulatory authorities, and drug sellers to identify fake and substandard medicines and remove them from the market. In addition, PMI partners with national medicines regulatory authorities in PMI focus countries to help strengthen local capacity to sample and test drugs found in shops and strengthen national drug quality laboratories to test the quality of drug samples collected from public and private outlets.

BUILDING CAPACITY AND HEALTH SYSTEMS

The gains achieved to date in malaria control can only be sustained if endemic countries have strong health systems. In addition to providing assistance to countries to roll out malaria-specific activities, PMI also helps build national capacity in a variety of cross-cutting areas that benefit both malaria and other health programs. PMI efforts to strengthen health systems have included:

- Support for the training of tens of thousands of health workers in malaria case management, diagnostic testing for malaria, and the prevention of malaria during pregnancy, including the use of IPTp, as well as training people to implement IRS activities.
- Providing technical assistance and programmatic support to strengthen systems to quantify malaria commodity requirements, strengthen stock management systems, and build health worker capacity in logistics management. Between 2011 and 2016, the percent of PMI focus countries with adequate stocks of ACTs and RDTs at the central level increased from 15 percent to 67 percent for ACTs and 10 percent to 67 percent for RDTs. PMI also serves as a flexible procurement source when other sources of malaria commodities are insufficient or delayed; in FY 2016, PMI filled eight emergency orders.
- Through support to the CDC's Field Epidemiology and Laboratory Training Program, PMI helped to build a cadre of ministry of health staff with technical skills in the collection, analysis, and interpretation of data for decision-making, as well as policy formulation and epidemiologic investigations. To date, PMI has supported more than 100 trainees in 11 PMI focus countries in Africa and 1 PMI program in the GMS.
- Contributing to key elements of global health security by working in synergy with the Global Health Security Agenda (GHSA), which includes countering antimicrobial resistance, strengthening national laboratory systems, supporting real-time surveillance, and investing in workforce development. PMI-supported community level programs provide the first point-of-care and referral for epidemic diseases as well as a platform for response to public health emergencies.

EXAMPLES OF PMI'S GLOBAL AND U.S. GOVERNMENT PARTNERSHIPS

From its very inception and launch 12 years ago, the U.S. President's Malaria Initiative (PMI) was created with the recognition that achieving its ambitious goals would not be possible alone and thus partnerships were recognized as central to PMI's malaria control efforts. PMI continues to maintain robust partnerships at the country, regional, and international levels to support NMCPs to expand the impact of malaria control activities. PMI works closely with the government of each focus country and with local and international partners to ensure that investments are strategically aligned with the country's overall malaria control plan, while leveraging financial and technical support from other partners. PMI's key multilateral and bilateral partners include:

Global Fund to Fight AIDS, T
Fund): PMI works closely with the Global F
global level to coordinate investments for malaria control to maximize impact and harmonize activities to ensure that these complement each other. The U.S. Government is the Global Fund's largest financial contributor
U.S. delegation to the Global F

Roll Back Malaria (RBM) Partnership:
the RBM Partnership, providing fi
for numerous RBM activities and participating in many of its tech-

World Health Organization (WHO): PMI provides targeted finan-

Program for defined activities that will help PMI achieve our objec-

PMI leverages support from the private and commercial sectors to ensure that these resources are being invested into appropriate and effective interventions and support coordination with government strategies and plans. Historically, this has primarily involved partnering with large companies who wish to protect their workforce through vector control as part of their corporate social responsibility portfolio.

To advance the global malaria control agenda, PMI also partners with foundations, including the Bill & Melinda Gates Foundation and the United Nations Foundation, as well as non-governmental organizations, whose primary function is advocacy such as Malaria No More.

PMI has long-standing relationships with non-governmental organizations and faith-based community organizations, which often have the ability to reach remote, marginalized, and underserved populations in PMI focus countries. Through support to community-based organizations, and in close coordination with NMCPs and local health authorities, PMI is improving community-level access to critical malaria prevention and treatment services while also building local capacity and ensuring program sustainability. To date, PMI has supported more than 200 local and international nonprofit organizations to deliver critical malaria services in all PMI focus countries.

Furthermore, PMI works closely with other U.S. Government programs, both on the ground in focus countries and at the headquarters level to synchronize PMI's work with other U.S. Government investments in global health and maximize the combined impact and avoid duplication. This collaboration includes, for example, the Peace Corps and the Global Health Security Agenda.

REAPING THE ECONOMIC BENEFITS OF MALARIA CONTROL

Global health programs such as PMI do more than save lives and protect people most vulnerable to disease. Our efforts promote the stability of communities and nations, while advancing American prosperity and security. Leading health economists consider malaria among the most cost-effective public health investments. A 50 percent reduction in global malaria incidence could produce $36 in economic benefits for every $1 invested globally, with an even greater estimated return on investment of 60:1 in sub-Saharan Africa.[5]

Reducing malaria transmission also promises to alleviate the burden that the disease places on already overstretched health systems in affected countries. In highly endemic countries, malaria typically accounts for up to 40 percent of outpatient visits and hospital admissions. Reducing malaria transmission levels in these countries has a positive effect on the rest of the health system by allowing health workers to focus on managing other important childhood ailments, such as pneumonia, diarrhea, and malnutrition. A PMI-funded study in **Zambia** showed substantial reductions in inpatient admissions and outpatient visits for malaria after the scale-up of malaria control interventions, and hospital spending on malaria admissions also decreased tenfold.[6] Reports from other PMI focus countries indicate dramatic reductions in child hospitalizations.

Malaria's damaging effects ripple well beyond the public health sector. The disease cripples economies by disrupting children's attendance at school, increasing absenteeism of the adult workforce, and causing out-of-pocket health expenditures for families. It is estimated that achieving malaria eradication will produce an estimated $2 trillion in economic benefits and save an additional 11 million lives over the period 2015–2040.[7] In the WHO African Region, malaria mortality reductions over the period 2000–2015 have increased life expectancy by 1.2 years; this has been valued at $1.8 trillion.[8]

ENDING MALARIA FOR GOOD

Despite remarkable gains against malaria in sub-Saharan Africa over the past decade, the disease remains one of the most common infectious diseases and a significant public health problem. The 2016 WHO World Malaria Report points out that, although global access to key anti-malarial interventions has continued to improve, critical gaps in coverage and funding are jeopardizing the attainment of global targets set forth by the Global Technical Strategy for Malaria 2016–2030. Sub-Saharan Africa continues to bear a disproportionately high share of the global malaria burden. In 2015, the region was home to 9 out of every 10 malaria cases and malaria deaths. Almost 400,000 people still die from malaria each year in sub-Saharan Africa, and children under five years of age remain particularly vulnerable, accounting for an estimated 70 percent of all malaria deaths. More than 830 children still die from malaria every day.

We are confronted with serious challenges, including resistance to artemisinin drugs and key insecticides; widespread availability of substandard and counterfeit malaria treatments; inadequate disease surveillance systems; waning country and donor attention as malaria burden drops; and unexpected crises. Progress has not been uniform throughout Africa, and in some countries, malaria control interventions will need to be scaled up further before substantial reductions in malaria burden can be expected. In contrast, other countries have progressed to a point where malaria is no longer a leading public health problem. The lives of millions of people have been transformed; their prospects for a healthy life greatly improved; and the future of their communities and countries enhanced by economic development unimpaired by malaria – moving ever closer to breaking the vicious cycle that keeps communities and countries impoverished.

Fighting malaria is a "best buy" in global health, creating opportunity and fostering growth and security, especially among the poor. In addition to the Goal 3 (Good Health) target of ending malaria by 2030, there are a number of examples of synergies between advances in malaria control and progress toward the 17 Sustainable Development Goals. In particular, malaria control directly contributes to the achievement of Goals 1 (No Poverty), 10 (Reduced Inequalities), and 16 (Peace and Justice).[9] The U.S. Government, through PMI, is a key partner in the global fight against malaria, working together with host country governments and the broader malaria partnership to maintain the momentum for malaria elimination and the achievement of the bold vision of a world without malaria.

5 Roll Back Malaria Partnership. Action and Investment to Defeat Malaria 2016–2030 (AIM) – For a Malaria-Free World.

6 Comfort, A.B., et al. 2014. Hospitalizations and Costs Incurred at the Facility Level after Scale-up of Malaria Control: Pre-post Comparisons from Two Hospitals in Zambia. Am. *J. Trop. Med.* Hyg., 90: 20-32.

7 Roll Back Malaria Partnership. Action and Investment to Defeat Malaria 2016–2030 (AIM) – For a Malaria-Free World.

8 World Health Organization, 2016 World Malaria Report.

9 Roll Back Malaria Partnership. Action and Investment to Defeat Malaria 2016–2030 (AIM) – For a Malaria-Free World.

Kharn Lina, URC

1. Outcomes and Impact

Global progress in the fight against malaria since 2000 has been historic. The World Health Organization (WHO) estimates that more than 6.8 million malaria deaths were averted worldwide between 2001 and 2015, primarily among children under five years of age in sub-Saharan Africa.[1] The Millennium Development Goal target of halting and reversing malaria incidence by 2015 has been attained. Dramatic decreases in estimated malaria deaths and illness have been achieved both globally and in U.S. President's Malaria Initiative (PMI) focus countries. These reductions have contributed to declines in overall child mortality. Eighteen PMI focus countries have documented declines in all-cause under-five mortality; these range from 8 percent (in **Benin**) to 67 percent (in **Rwanda**) (see Appendix 3).[2] Of note, 11 countries have achieved a greater than 40 percent mortality reduction since PMI began in those countries.

The U.S. Government's leadership in the malaria fight through PMI has been essential to these gains. The commitment and action of PMI focus countries themselves, in collaboration with affected communities, health workers, and local and international partners, is resulting in a rapid roll back of malaria. As a result of these unprecedented successes, the global malaria community has embraced an aspirational goal of malaria eradication. PMI's Strategy for 2015–2020 supports this vision of a world without malaria with three primary objectives to be achieved through efforts in five strategic areas (see Box).

REDUCING MALARIA MORTALITY AND MORBIDITY IN PMI FOCUS COUNTRIES

Global malaria deaths (all ages) declined by an estimated 22 percent between 2010 and 2015, from 554,000 to 429,000 deaths.[3] Among children under the age of five, the number of malaria deaths has declined by nearly one-third (29 percent) over the same period. Across the 19 PMI focus countries in sub-Saharan Africa, malaria mortality rates decreased by 29 percent between 2010 and 2015, with 10 countries achieving 20 percent to 40 percent reductions.

During this period, the proportion of the population at risk for malaria in sub-Saharan Africa that tested positive for the malaria parasite declined to a low of 13 percent in 2015,[4] and the number of malaria-infected people has dropped from 131 million to 114 million. In Africa, 80 percent of all

PMI's Strategy 2015–2020

Vision: A World without Malaria

Objectives:

1. Reduce malaria mortality by one-third from 2015 levels in PMI focus countries, achieving a greater than 80 percent reduction from PMI's original baseline levels.
2. Reduce malaria morbidity in PMI focus countries by 40 percent from 2015 levels.
3. Assist at least five PMI focus countries to meet the WHO criteria for national or sub-national pre-elimination.

Strategic areas of focus:

1. Achieving and sustaining scale of proven interventions
2. Adapting to changing epidemiology and incorporating new tools
3. Improving countries' capacity to collect and use information
4. Mitigating risk against the current malaria control gains
5. Building capacity and health systems

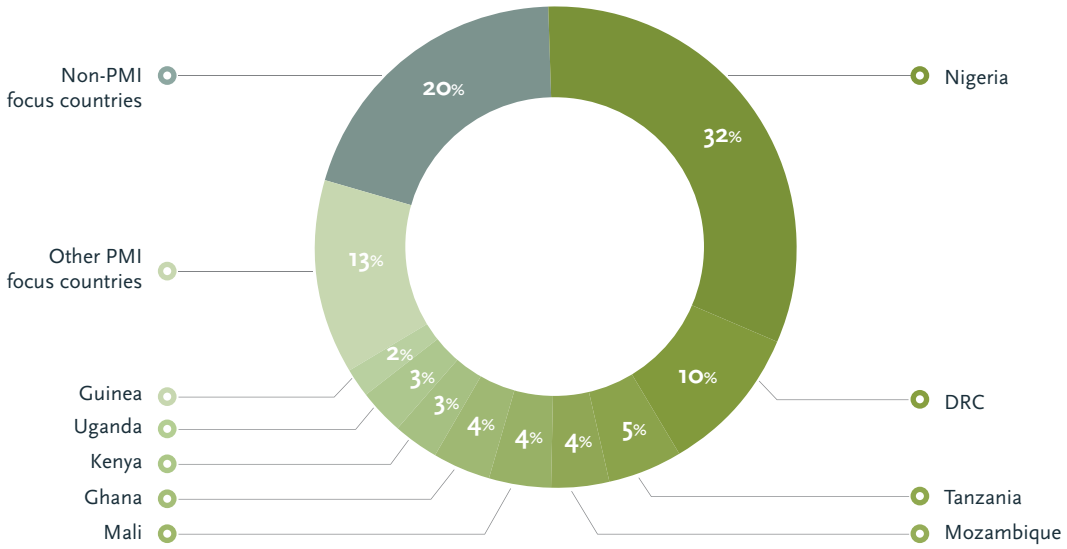
1 World Health Organization, 2016 World Malaria Report.

2 While reductions in all-cause child mortality may be the result of both malaria and non-malaria-related child health interventions, PMI relies on this indicator to measure the impact of malaria control interventions in accordance with the recommendations of the Roll Back Malaria Monitoring and Evaluation Reference Group. All-cause child mortality captures both the direct and indirect effects of malaria.

3 World Health Organization, 2016 World Malaria Report.

4 World Health Organization, 2016 World Malaria Report.

Figure 1. Distribution of Malaria Cases among Countries in sub-Saharan Africa (2015)



Source: World Health Organization, World Malaria Report 2016.
Note: "Other PMI focus countries" includes: Angola, Benin, Ethiopia, Liberia, Madagascar, Malawi, Rwanda, Senegal, Zambia, and Zimbabwe.

malaria cases occur in PMI focus countries (see Figure 1, above).

Estimated malaria incidence (i.e., new malaria cases) fell 21 percent globally as well as in Africa between 2010 and 2015.[5] Based on this progress, the WHO estimates that 20 sub-Saharan countries are on track to achieve the Global Technical Strategy (GTS) 40 percent target reduction in malaria transmission by 2020 – 10 of which are PMI focus countries. Between 2010 and 2015, malaria case incidence decreased by 19 percent across the 19 PMI focus countries in sub-Saharan Africa, and 9 countries have achieved 20 percent to 40 percent reductions.

5 World Health Organization, 2016 World Malaria Report.

A few countries in sub-Saharan Africa have seen increases in reported malaria cases during 2015, which are likely due to multiple factors including increased care seeking, improved case reporting, and in some cases, actual increases in malaria transmission. PMI is working with national governments and partners to verify these increases in reported cases, investigate the potential causes, and respond appropriately in those instances where increases in malaria burden are identified.

ASSISTING PMI FOCUS COUNTRIES TO REACH PRE-ELIMINATION/ELIMINATION

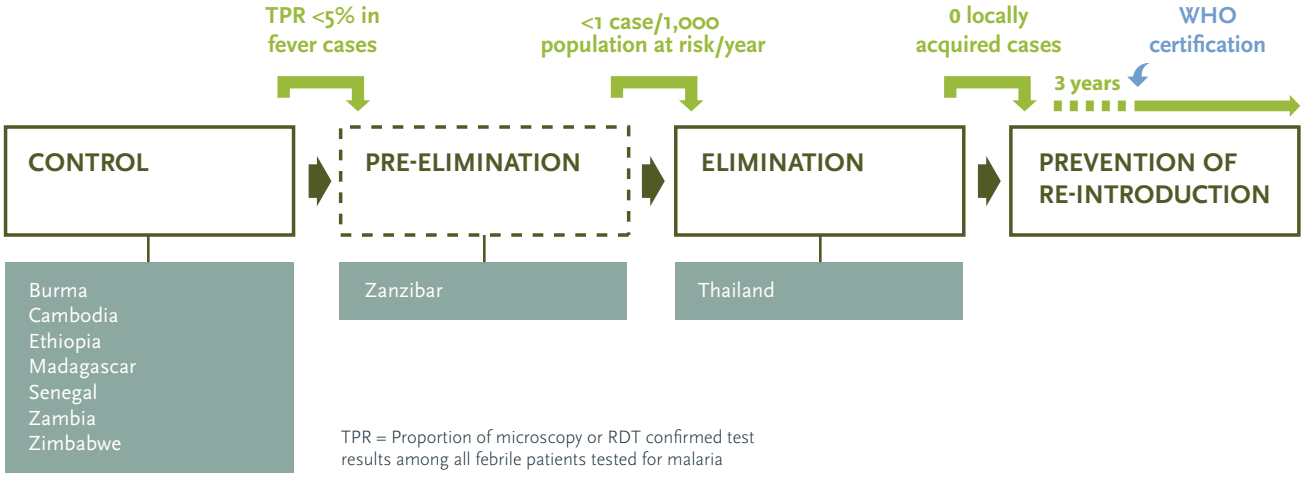
A number of countries have set their sights on eliminating malaria in the next 30 years. The leaders of all six countries in the Greater Mekong Subregion have committed to eliminating malaria by 2030. In FY 2016, PMI conducted a baseline inventory to determine which of the focus countries had (1) adopted national strategies that include a goal of national or sub-national malaria elimination and (2) allocated resources for national or subnational activities in support of that goal. Eight PMI focus countries (**Burma, Cambodia, Ethiopia, Madagascar, Senegal, Thailand, Zambia,** and **Zimbabwe**) and Zanzibar in the Republic of **Tanzania** were identified as having met these criteria.[6]

In **Zanzibar** (but not mainland Tanzania), test positivity rates[7] have dropped below 5 percent, and in **Thailand**, below 1 percent, making it the only PMI focus country in the elimination phase. These countries now have built capacity to detect and re-

6 In all of these countries, the target date for elimination is 2025 or later.

7 Proportion of microscopy or rapid diagnostic test (RDT) confirmed test results among all febrile patients tested for malaria.

Figure 2. Status of PMI Focus Countries with National Strategies Targeting Elimination



spond to individual malaria cases. The remaining seven countries have set goals for national or sub-national elimination and are investing resources toward achieving that goal (see Figure 2, above).

In these countries, PMI is supporting activities to achieve the criteria for pre-elimination, including strengthening surveillance systems. In some of these countries, PMI is assisting to develop surveillance systems to rapidly detect, report, characterize, and further investigate individual malaria cases in targeted areas. This approach aligns with Pillar 3 of the GTS, which is to transform malaria surveillance into a core intervention. PMI also is providing support in targeted countries to: (1) conduct active clinical case finding; (2) implement low-dose primaquine treatment to prevent the onward transmission of *falciparum* malaria; and (3) carry out various operational research activities, including an assessment of the effectiveness of reactive case detection versus targeted mass drug administration to reduce malaria incidence and prevalence.

LOOKING FORWARD

Since 2000, the global effort to roll back malaria has been an unprecedented success, which brings the GTS and PMI objectives for 2020 within reach, assuming sufficient resources are available. Still, the number of child deaths from malaria remains unacceptably high, and progress in the highest burden countries remains uneven. In 2015 alone, an estimated 303,000 children under the age of five died from malaria in sub-Saharan Africa, resulting in the loss of the life of a child every 2 minutes.[8] To achieve a world without malaria, interventions must continue to be scaled up and targeted where needed; use of these interventions needs to be optimized; tracking of malaria cases and deaths must be supported by strengthened surveillance systems; capacity must be built for countries to manage and implement malaria control activities; and investments in malaria control must be increased three-fold over the next 15 years.[9]

8 World Health Organization, 2016 World Malaria Report.

9 World Health Organization, 2015. Global Technical Strategy for Malaria 2016–2030.

2. Achieving and Sustaining Scale of Proven Interventions

Vector Control – Insecticide-Treated Mosquito Nets

Long-lasting insecticide-treated nets (ITNs) continue to be the most commonly used tool for malaria prevention worldwide. The U.S. President's Malaria Initiative's (PMI's) strategy for ITNs is guided by the World Health Organization (WHO) recommendation for universal coverage of the entire population at risk for malaria with effective vector control interventions, primarily long-lasting ITNs or indoor residual spraying (IRS). PMI supports countries to achieve and maintain universal coverage with long-lasting ITNs through periodic mass campaigns and continuous distribution channels.

In FY 2016, PMI procured more than 30 million ITNs and distributed more than 38 million (including ITNs that had been procured in the previous year) in PMI focus countries. Cumulatively, since 2006, PMI has procured more than 227 million ITNs. PMI also has supported the distribution of more than 256 million ITNs in that same period (which includes nearly 172 million ITNs procured by PMI and an additional 85 million procured by other donors but distributed with PMI resources[1]) (see Appendix 2). These ITNs are helping to protect an estimated 463 million people from malaria infection. Regardless of the source of ITN procurement, PMI provides significant technical assistance in focus countries for the distribution of ITNs, the promotion of their use, and ITN program monitoring and evaluation.

In the 11 years since PMI began, there has been impressive progress in ITN ownership and use across PMI focus countries. Overall, ITN ownership of at least 1 ITN per household has increased from a median baseline of 36 percent to 68 percent (range: 31 percent to 93 percent), and ITN use in children under five has increased from a median baseline of 22 percent to 52 percent (range: 9 percent to 84 percent) (see Appendix 3). While some countries are making impressive progress with respect to ITN ownership and use (such as **Madagascar** and **Mali**, which report more than 90 percent ownership and 84 percent and 71 percent use, respectively), others still are scaling up (see Figures 1 and 2, page 20).

PMI tailors approaches to increase ITN access and promote ITN use according to each country's systems and epidemiology. Data suggest that in many countries, the main limiting factor to ITN use remains insufficient access to ITNs to protect all household members.[2,3] Thus, PMI remains focused on increasing the number of ITNs available to at-risk populations. In addition to procuring ITNs, PMI supports periodic mass distribution campaigns in all countries and also strengthens continuous ITN distribution channels. To complement the procurement and distribution of ITNs, PMI supports social and behavior change communication activities to maintain high net ownership and ensure that ITNs are used correctly and consistently. In addition to supporting monitoring of access and use through household surveys, PMI monitors net durability and insecticide efficacy.

ACHIEVING HIGH NET OWNERSHIP – MASS DISTRIBUTION CAMPAIGNS

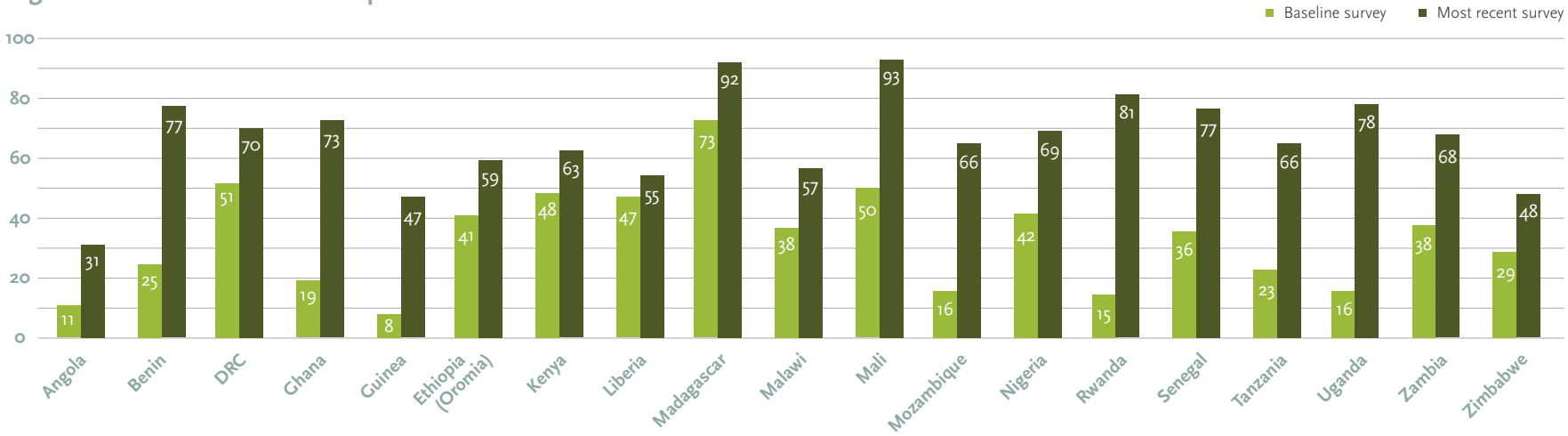
Mass distribution campaigns, which are recommended approximately every 3 years, can enable countries to achieve equitable, universal ITN coverage quickly. Campaigns are also an opportunity to utilize social and behavior change communica-

1 Due to the lead time between procurement and in-county distribution, approximately 55 million ITNs procured by PMI have not yet been distributed.

2 Universal coverage with insecticide-treated nets – applying the revised indicators for ownership and use to the Nigeria 2010 malaria indicator survey data. 2013. Kilian, A., et al., *Malaria Journal*, 12:314.

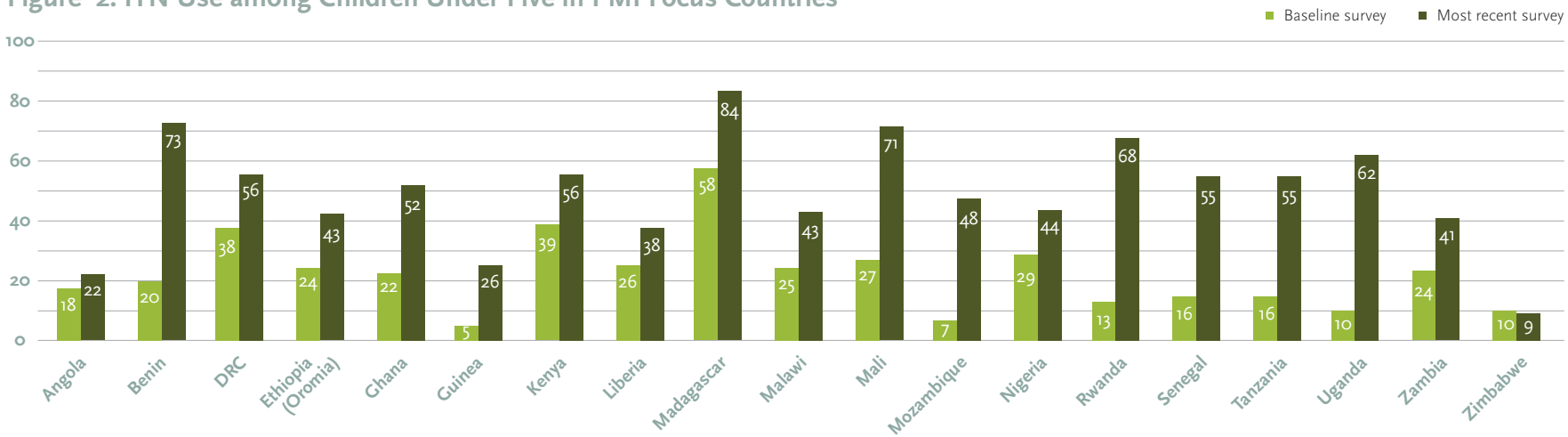
3 Recalculating the net use gap: a multi-country comparison of ITN use versus ITN access. 2014. Koenker, H. and Kilian, A., *PLoS ONE*, 21;9(5):e97496.

Figure 1. Household Ownership of at Least One ITN in PMI Focus Countries



Note: Household ownership is defined as the percentage of households surveyed that owned at least one ITN. Data shown are from nationwide household surveys. Refer to Appendix 3 (Figure 2) for more detail.

Figure 2. ITN Use among Children Under Five in PMI Focus Countries



Note: ITN use is defined as the percentage of children under the age of five who slept under an ITN the night before the survey. The denominator includes all those participating in the survey, regardless of whether or not they had access to a net. Data shown are from nationwide household surveys. Refer to Appendix 3 (Figure 3) for more detail.

tion to disseminate and reinforce key messages around net ownership, use, and care. All PMI focus countries in sub-Saharan Africa have completed at least one national or sub-national campaign between 2009 and 2016. In FY 2016, working with partners, PMI supported mass campaigns in 14 countries (**Angola, Burma, Democratic Republic of the Congo [DRC], Ethiopia, Ghana, Guinea, Kenya, Laos, Madagascar, Malawi, Mozambique, Nigeria, Senegal,** and **Zimbabwe**). Highlights include:

- PMI facilitated **Burma's** mass distribution efforts by procuring 553,500 ITNs and providing assistance to the national malaria control program (NMCP) to distribute them in 47 high-risk townships in 11 states and regions. These ITNs were distributed between August and December 2015, providing protection to more than 1 million people.

- In **DRC**, where the country undertakes rolling nationwide mass campaigns, PMI collaborated with other donors to distribute ITNs in FY 2016. In Mongala and Tshuapa Provinces, PMI procured more than 1.9 million ITNs with the Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) covering the distribution costs. In Sud-Ubangui Province, PMI supported the procurement and distribution of 1.5 million ITNs. Also in 2016, Global Fund supported the mass campaign in six other provinces (Sud-Kivu, Nord-Kivu, Lualaba, Haut-Katanga, Haut-Lomami, and Tanganyika), and the U.K. Department of International Development supported it in Nord-Ubangui Province.

- PMI's support to **Guinea's** 2016 nationwide ITN mass distribution campaign focused on 14 of the country's 33 prefectures, plus 5 communes in Conakry. Global Fund resources supported the remainder of the country. PMI procured 1 million ITNs and supported the distribution of more than 3.3 million nets to more than 833,000 households. PMI also trained more than 14,000 people in micro-planning, enumeration, distribution, and communication skills. Furthermore, PMI supported a comprehensive social and behavior change communication (SBCC) campaign to promote net use including television, radio spots, and home visits that reached more than 2.9 million people with key messages on correct and regular net use.

- In **Nigeria**, as part of the country's rolling nationwide mass campaign, PMI procured 8.7 million ITNs, 93 percent of which were distributed in the 3 high-burden states of Benue, Kogi, and Oyo. The remaining nets were distributed to internally displaced people in Northern Nigeria. Global Fund is supporting procurement and distribution of ITNs in other states.

- In **Zimbabwe**, PMI procured more than 900,000 ITNs and supported their distribution in the 13 PMI-supported, high-burden districts within Mashonaland East, Mashonaland Central, and Midlands Provinces. These three provinces account for more than 60 percent of malaria mortality in the country. As part of the mass campaign, PMI supported community sensitization meetings, SBCC, and educational activities to promote correct and consistent use of nets. The campaign reached more than 1.3 million people, covering 96 percent of the population living in these districts.

MAINTAINING HIGH NET OWNERSHIP – CONTINUOUS DISTRIBUTION

Continuous distribution can be an important method to maintaining high ITN coverage over time, sustaining the coverage achieved by periodic mass distributions. PMI works with countries to assess infrastructure, resources, and cultural norms to determine the most appropriate combination of ITN distribution channels to maintain high coverage effectively and equitably. The most common ITN continuous distribution channels are health facility-based distribution to pregnant women through antenatal care (ANC) services and to children through Expanded Program on Immunization programs. Other distribution approaches include school-based and community-based channels. Continuous distribution also provides a platform to disseminate key messages promoting net ownership, use, and care.

In FY 2016, all PMI focus countries supported ITN distribution through at least one continuous distribution channel. Examples include:

- **Senegal** has a multi-channel routine distribution system for long-lasting ITNs through health facilities, schools, community-based organizations, and the private sector, distributing 291,192 through these channels, and complementing the mass campaign efforts underway during FY 2016. These efforts have contributed

Sarah Hoibak, VectorWorks, Courtesy of Photoshare

"My Net Is My Friend" – the Story of a Ghanaian Primary School Child

Festus Akun is a 9-year-old student at Amanhyia Roman Catholic Primary School in the Eastern Region of Ghana. Like many other children in Ghana, Festus now rests safe and sound, protected from mosquitoes because he sleeps under an insecticide-treated mosquito net.

However, his sleep was not always so peaceful. Festus recounts: "Mom and I used to stay up all night chasing away mosquitoes … but it seemed like whatever we did, my mom and I would get sick. We always lived in fear of malaria." His mother lamented that her son often missed school as a result of malaria.

Since 2013, Ghana's National Malaria Control Program, in partnership with PMI, has distributed ITNs to students in primary school classes 2 and 6. Festus is among the more than 3 million children in public and private primary schools who have benefitted from the free ITN distribution program since its inception.

Through the accompanying malaria prevention education program, young Festus and millions of Ghanaian school children and their families have learned about proper use and care of ITNs. SBCC messages teach about the importance of sleeping under ITNs all night every night, how to care for ITNs to prevent damage, and the importance of not washing ITNs in streams and ponds to prevent pollution of the environment.

In May 2016, Festus's teacher gave him his own mosquito net. After school, he quickly gave it to his mother to air out and hang for him. After 2 months of sleeping under the ITN, Festus enthusiastically explains: "My net is my friend. I wake up every morning feeling very healthy without any experience of a bite from a mosquito and go to school to learn and play, feeling very well and active. Thanks to the people who gave us the mosquito nets."

Festus has since successfully completed his primary class 2 and advanced to primary class 3. He and his mother are looking forward to a bright future without malaria.

to maintaining high net coverage, with the country's latest continuous Demographic and Health Survey (DHS) recording 77 percent of households owning at least one ITN.

- With the launch of the National Malaria Control Program's *Chandarua Kliniki* (Bednet at the Clinic) program in **Tanzania**, pregnant women and children have access to free ITNs at health facilities. In the regions of Mtwara and Mwanza, the program delivers free ITNs to pregnant women at their first ANC visit, as well as to infants during their well-child visit for measles vaccination. Furthermore, PMI continues to support the School Net Program, which expanded in FY 2016 to cover seven regions during the fourth round of distribution. In FY 2016, a total of more than 1.4 million ITNs were distributed through these channels.

- PMI is supporting **Zambia's** expansion from facility-based distribution channels to include school-based and community-based distribution. In FY 2016, a pilot school-based distribution of ITNs was conducted in four districts in Luapula, a province with a high malaria burden. In the pilot, which is a collaborative effort between the Ministry of Education and the Ministry of Health, ITNs were given to students in grades 1 and 4. The number of classes selected to receive nets is determined in consultation with local authorities and based on target ITN coverage levels. Based on lessons learned from this pilot, Zambia plans to update its Continuous Distribution Guidelines, which will guide implementation of school distribution in the remaining districts in the province and eventually scale up to other provinces in Zambia.

Vector Control – Indoor Residual Spraying

PMI continues to support indoor residual spraying (IRS) as a tool to fight malaria in places where the primary mosquito vectors rest indoors and where mosquito resistance to pyrethroid insecticides, the only insecticide class currently available for ITNs, exists. IRS, the application of effective insecticide to the interior walls of houses, can be used as an alternate or possibly complementary tool to long-lasting ITNs to further prevent mosquitoes from transmitting malaria. In FY 2016, PMI supported NMCPs to implement IRS in 12 countries, which resulted in spraying more than 4 million houses, and protecting more than 16 million people. Examples of FY 2016 IRS activities include:

- PMI supported the drafting and dissemination of a comprehensive IRS training curriculum for all cadres of workers, designed to help governments and private partnerships to prepare for spray campaigns. PMI also rolled out a number of new tools to help campaigns run smoothly, including digitized data collection verification tools in **Rwanda** and **Tanzania**.

- In **Madagascar**, PMI supported IRS in five high-transmission districts. In FY 2016, 190,000 structures in 3 districts of the east coast and 120,000 structures in 2 south-east coast districts were sprayed, protecting approximately 1.2 million people in total. Strong collaboration with partners, including the Peace Corps, and engagement of local traditional leaders contributed to reduced refusal rates and improved coverage. Furthermore, a mobile performance management tracking tool was piloted to monitor daily operations, and an e-inventory system was used to track insecticide and equipment stocks.

PMI continues to build capacity for national governments and institutions to implement IRS, training more than 25,000 people in FY 2016 on the various aspects of IRS operations. In addition, PMI organized an environmental compliance training workshop in **Senegal** for NMCP and relevant government environmental agency counterparts. Participants from government institutions attended from 11 PMI focus countries. The goal was to ensure participants have the tools and knowledge base to monitor IRS campaigns, while protecting the environment, seasonal workers, and communities.

See Chapter 4 to read about entomological monitoring and Chapter 5 for insecticide resistance detection and response.

Spotlight on Partnerships: UNITAID NgenIRS

The UNITAID-funded NgenIRS Project, which was launched in February 2016, aims to accelerate and expand access to, and adoption of, new third generation IRS formulations. These formulations are long-lasting, non-pyrethroid insecticides, which are not yet compromised by insecticide resistance and increase the effective lifetime of IRS products. Thus, the objective of this market-shaping intervention is to reduce malaria transmission through an increased uptake of effective and affordable long-acting insecticides for IRS. The NgenIRS Project leverages existing PMI- and Global Fund-supported IRS programs and allows countries to maintain or even increase current IRS coverage by providing co-payment funding for these more expensive insecticides. In FY 2016, PMI contributed technical feedback as a key project partner to the project. Five PMI focus countries were selected to participate in the project in FY 2016, namely Ethiopia, Mali, Mozambique, Rwanda, and Zambia.

Brant Stewart, RTI

Malaria in Pregnancy

Malaria infection during pregnancy contributes to newborn and maternal morbidity and mortality. For the unborn child, maternal malaria increases the risk of low birth weight, miscarriage, stillbirth, and premature delivery. In lower prevalence areas, pregnant women, particularly those in their first or second pregnancies, are particularly vulnerable to malaria as pregnancy reduces a woman's immunity to malaria, making her more susceptible to malaria infection and increasing the risk of illness, severe anemia, and death.

In areas with moderate to high levels of malaria transmission, WHO recommends a three-pronged approach to reduce the burden of malaria infection among pregnant women: (1) administration of intermittent preventive treatment for pregnant women (IPTp) with sulfadoxine-pyrimethamine (SP); (2) provision and promotion of ITNs to pregnant women; and (3) prompt diagnosis and effective treatment of malaria and anemia. PMI supports delivery and promotion of these services through an integrated antenatal care service delivery platform and promotes collaboration between national malaria control programs and reproductive and maternal health programs.

ITN USE AMONG PREGNANT WOMEN

ITNs are crucial to protect women and their fetuses throughout pregnancy, especially during the first trimester of pregnancy, when women may not know yet they are pregnant and when IPTp is not recommended. To ensure that pregnant women receive ITNs as early as possible, PMI supports coverage of all women of reproductive age with ITNs through mass campaigns as well as reaching pregnant women through continuous routine distribution during ANC. To complement distribution of ITNs, PMI supports SBCC to promote correct and consistent use of ITNs by pregnant women. ITN use among pregnant women, measured through nationwide household surveys, continues to improve in most PMI focus countries and has increased from a median of 20 percent at baseline to 50 percent (range: 6 percent to 82 percent) in the most recent survey (see Figure 3, next page).

IPTP COVERAGE

The use of IPTp during pregnancy has been shown to significantly reduce low birth weight and maternal anemia. To date, coverage of pregnant women with at least 2 doses of IPTp in PMI focus countries has increased from a median of 14 percent at baseline to 37 percent in the most recent survey (see Figure 4, next page). While PMI continues to monitor IPTp2 coverage for tracking improvement over time, WHO recently updated its recommendation to provide at least 3 doses and has also begun monitoring coverage of IPTp3. For the 12 PMI focus countries in which the indicator IPTp3 was measured in nationwide household surveys, coverage currently ranges from 8 percent to 60 percent.

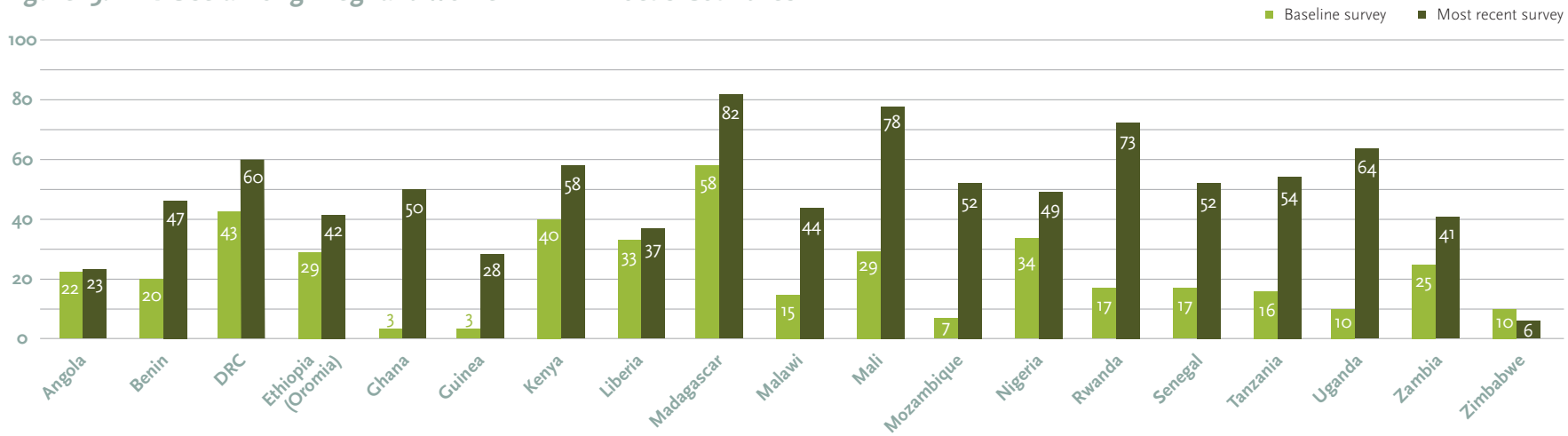
In FY 2016, PMI procured more than 7 million SP treatments for IPTp for 6 PMI focus countries. PMI supports SBCC to promote timely and regular attendance at ANC, adherence to national malaria in pregnancy (MIP) guidelines, and adherence to provider instructions about prevention of MIP, including IPTp use. **Ghana, Malawi,** and **Zambia** continue to have the greatest success with IPTp2 coverage reaching 78 percent, 63 percent, and 73 percent coverage, respectively (see Figure 4).

Several PMI focus countries have made considerable progress in IPTp coverage including:

- **Benin's** national policy supports free distribution of SP and ITNs to pregnant women presenting at ANC clinics. In FY 2016, PMI trained 23 regional trainers, who then trained frontline health workers in their region, on the revised IPTp guidelines, which recommend monthly SP treatment beginning early in the second trimester of pregnancy up until delivery. PMI also helped improve compliance with these IPTp guidelines by using multi-channel SBCC strategies to inform both health providers and pregnant women on how SP is administered and its benefits. Routine data collection systems showed that in FY 2016, approximately 60 percent of women who attended at least 2 ANC visits received IPTp2 under direct observation of a health worker, compared to 50 percent reported in FY 2015. To support these efforts, PMI procured more than 1 million treatments of SP, completely covering the national need.

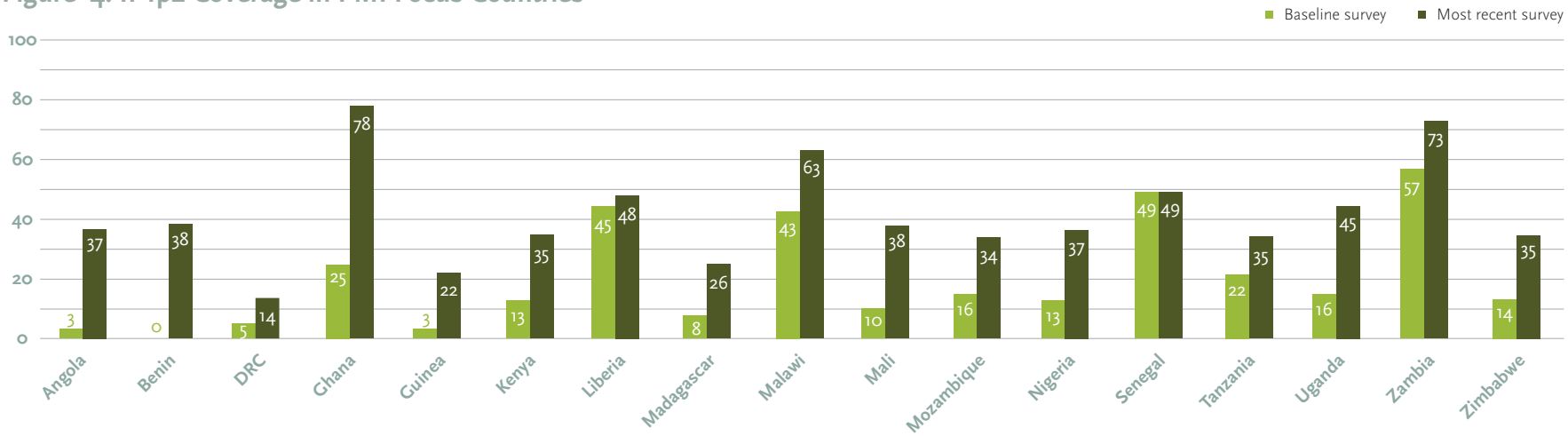
- The **Kenya** National Malaria Strategy 2008–2017 recommends that all pregnant women in malaria endemic counties receive at least 3 doses of IPTp. The 2015 Kenya Malaria Indicator Survey (MIS) showed substantial improve-

Figure 3. ITN Use among Pregnant Women in PMI Focus Countries



Note: ITN use is defined as the percentage of pregnant women who slept under an ITN the night before the survey. The denominator includes all those participating in the survey, regardless of whether or not they had access to a net. Data shown are from nationwide household surveys. Refer to Appendix 3 (Figure 4) for more detail.

Figure 4. IPTp2 Coverage in PMI Focus Countries



Note: IPTp2 is defined as at least two doses of SP during the last pregnancy, with at least one dose given during an antenatal clinic visit. Data shown are from nationwide household surveys. Refer to Appendix 3 (Figure 5) for more detail.

ment in the percentage of pregnant women who received 2 or more doses of IPTp in these malaria endemic counties. While coverage was only 22 percent in 2010, it increased to 56 percent in 2015. However, only 38 percent of pregnant women in malaria endemic regions received at least 3 doses of IPTp, which is well below the target of 80 percent in Kenya's Strategy. Thus, in FY 2016, PMI supported the training and orientation of 3,991 health facility workers and 5,500 community health workers (CHWs) on MIP. Since CHWs are critical to ensuring increased demand of services and referring patients to health facilities, engaging them in MIP activities is expected to increase the uptake of IPTp3.

- In **Malawi**, PMI distributed 930,826 ITNs at ANC clinics as well as labor and delivery wards. In addition, PMI distributed 872,000 SP tablets for IPTp at ANC. In 2016, PMI supported training of health workers in the new IPTp guidelines recommending 3 or more doses, supplementing the training that had been conducted in 2014–2015. Malawi has seen a doubling in the percent of pregnant women who received at least 3 doses of IPTp, from 12 percent in the 2014 MIS to 30 percent in the 2015–2016 DHS.

Seasonal Malaria Chemoprevention

Seasonal malaria chemoprevention (SMC) is a recommended approach to prevent malaria (especially severe malaria) among young children in areas with highly seasonal malaria transmission. SMC involves the administration of a curative dose of antimalarial drugs (amodiaquine plus sulfadoxine-pyrimethamine [AQ+SP]) at monthly intervals to all children aged 3–59 months without malaria symptoms in a targeted area over a limited (3-month) transmission season. WHO recommends SMC in the Sahel sub-region of sub-Saharan Africa, where *P. falciparum* is sensitive to both antimalarial medicines. PMI continues to support the NMCPs in **Mali** and **Senegal** to implement SMC. PMI provides funding for key aspects of the campaigns including training and supervision of health workers, procurement of SMC drugs, and monitoring and evaluation of program implementation and impact. Recent highlights include:

- In **Mali**, after PMI-supported operational research showed a 65 percent decline in parasite prevalence following SMC (*BMC Infectious Diseases*, forthcoming), the Government of Mali expanded the program nationwide. In 2016, all 64 districts were covered with SMC, including 10 supported by PMI, with the rest supported by various partners including UNICEF, Catholic Relief Services, *Médecins Sans Frontières*, and the World Bank. The Government of Mali provided funding for 15 districts. In total, PMI supported SMC services to more than 600,000 children under the age of five in FY 2016. Across all partners, SMC was provided to more than 3 million children under five years of age nationwide.

- In **Senegal**, PMI has provided technical assistance for the implementation of SMC as well as procured SMC drugs for the last 4 years (FY 2013–FY 2016), resulting in protection from malaria for approximately 644,000 children per year in 4 regions. In 2016, the number of children treated in each round ranged from 620,386 to 624,802 out of a target of 644,830.

Malaria Diagnosis and Treatment

Control or elimination of malaria and reduction in malaria morbidity and mortality cannot be achieved without timely, accurate, and effective case management. In all focus countries, PMI supports universal diagnostic testing to properly identify patients with malaria and immediate treatment with an appropriate, quality-assured artemisinin-based combination therapy (ACT) for those who test positive for malaria.

Together with partners and NMCPs, PMI is supporting the scale-up of prompt, high quality case management at health facility and community levels. During FY 2016, PMI supported training for more than 51,000 health workers in case management and more than 43,000 health workers in the procedures for diagnostic testing for malaria. In addition, PMI procured more than 77 million rapid diagnostic tests (RDTs) and 44 million ACTs. To date, PMI has procured more than 306 million RDTs and 421 million ACTs to support appropriate malaria case management in PMI focus countries. PMI's contributions complemented those of countries themselves as well as those of other donors.

Through these efforts, the proportion of suspected malaria cases that are confirmed with laboratory tests and treated with a recommended antimalarial drug combination continues to increase in nearly all focus countries, with 15 countries reaching more than 60 percent confirmation of malaria cases by diagnostic test, 10 of which met or exceeded 80 percent confirmation (see Figure 5, page 30). These efforts have greatly expanded access to life-saving treatments for millions of malaria patients in PMI focus countries.

STRENGTHENING LABORATORY DIAGNOSTIC CAPACITY AND QUALITY

One of the challenges in scaling up case management is ensuring sustained quality of malaria diagnostic testing. PMI works with NMCPs and partners to support routine malaria diagnostics training on RDTs and microscopy and in FY 2016 supported the training of more than 41,000 clinicians and laboratory technicians in procedures for quality diagnostic testing for malaria. PMI supports key components of a comprehensive quality assurance program aimed at improving and sustaining quality microscopy diagnostics services: establishment of a WHO-certified national archive of malaria slides (NAMS) and participation of country microscopists in a WHO external competency assessment for malaria microscopists (ECAMM) course.

A NAMS is a well-characterized and high-quality reference slide set,[4] which can serve as a critical tool for NMCPs to help improve, maintain, and monitor malaria diagnostic capacity. NAMS are used by countries to conduct malaria microscopy training, competency assessments of microscopists, and proficiency testing of microscopists as part of External Quality Assessment programs. PMI is supporting the establishment of NAMS in **DRC, Ethiopia, Ghana, Madagascar, Malawi,** and **Zambia**. Activities include the purchase of equipment and supplies, trainings for key staff responsible for developing the slide bank, and the initiation of sample collection and slide development. Examples of FY 2016 accomplishments include:

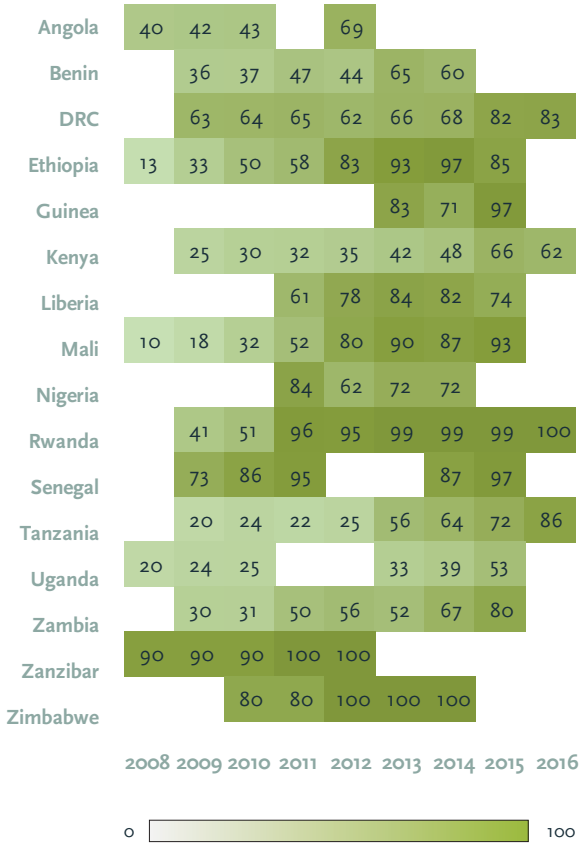
- PMI provided support for final external validation of NAMS in **Ethiopia** and **Ghana**. The Ghana NAMS is located at Kintampo Health and Research Centre and contains more than 6,300 high quality and validated slides. It is currently being used to support a variety of country-level training and quality assurance (QA) activities.
- In **Zambia**, 10 laboratory technicians were trained in NAMS development, and sample collection began in 3 provinces where approximately 2,000 slides have been prepared to date.

The purpose of the ECAMM course is to certify a national core group of expert microscopists, an essential resource for all malaria QA programs. These country level experts then participate in and lead microscopy trainings and support national QA programs as supervisors who build microscopy capacity at facilities. In most countries, participants are usually microscopists who have demonstrated high competency.

- PMI supported 27 participants from 6 countries to attend ECAMM courses in Ethiopia, Kenya, and Senegal. Twenty five (93 percent) passed with a WHO Level 1 or Level 2 equivalent, the highest levels of proficiency, receiving certification. In **Ethiopia**, all 13 national and regional

4 Malaria Microscopy Quality Assurance Manual – Version 2, WHO, 2016.

Figure 5. Improvements in Percentage of Reported Malaria Cases Confirmed by Diagnostic Test in PMI Focus Countries



Note: Countries included in this figure are those for which data are available. Data sources: Health Management Information Systems (HMIS), Outreach Training and Supportive Supervision (OTSS) visits, Malaria Operational Plans (MOPs), implementing partners, and NMCPs. Because data sources and case reporting practices vary by country, these data show progress over time within countries but are not intended for comparison across countries.

reference laboratory staff that attended the course passed with Level 1 or Level 2 accreditation, an accomplishment the WHO praised as a "historic performance."[5] PMI partners are now working with WHO and AMREF Health Africa to continue implementing this rigorous standard, which will build a core group of microscopy experts across the continent.

- In **DRC**, PMI supported 20 participants from central and provincial health levels to participate in a country-led advanced microscopy course. Course participants are now expected to lead the establishment of relevant laboratory procedures within their facilities, to share their knowledge with colleagues, and to continue to work as laboratory outreach training and supportive supervision (OTSS) supervisors in order to implement the malaria case management QA system in their province. Four of the best performers from this course were supported to participate in the WHO ECAMM course at Cheikh Anta Diop University in Dakar, Senegal; three received WHO certification.

IMPROVING CLINICAL MANAGEMENT OF MALARIA

Strengthening management of febrile illness and malaria by clinicians is another key focus area for PMI. Clinicians at all levels of the health system must be able to determine when to order a malaria test, recognize signs of severe malaria, use test results when making clinical decisions, and treat and follow up with patients appropriately. PMI supports up-to-date training in case management of malaria for practicing clinicians (in-service) as well as those in school (pre-service), in addition to targeted mentoring and coaching to build and maintain clinical skills. During FY 2016, PMI supported training for more than 51,000 health workers in malaria case management.

- In **Tanzania**, a multi-pronged approach to strengthening case management led to improvements in key indicators of clinical care performance. PMI collaborated with the NMCP to train the 62 clinical staff at different levels in the Eastern Zone that were newly hired or had not received prior training. In addition, 215 supervisors were trained and conducted 3 rounds of joint clinical and laboratory OTSS in 8 high burden regions. High-volume, low-scoring facilities were prioritized for repeated visits to maximize impact. As a result, the percent of health facilities checking for danger signs indicative of severe malaria rose from 71 percent to 89 percent, and correct prescribing practices based on test results rose from 88 percent to 97 percent. At the most recent visit, 88 percent of health facilities met or exceeded the minimum performance target for clinical case management.

- In addition to PMI's support for in-service training and supervision, efforts also have been made to update pre-service training for clinical and laboratory staff. Following the FY 2015 training of nearly all of **Malawi's** existing nurses and clinical officers on updated national guidelines for case management, PMI supported pre-service training for new nursing and clinical graduates in FY 2016. Support included the training of 22 lecturers across 8 major pre-service training institutions, followed by the extra-curricular

5 Universal Diagnosis and Treatment to Improve Maternal and Child Health, MalariaCare PY4 Annual Report.

Chris Thomas, PMI

Bringing Life-saving Commodities the Last Mile: The Story of a Zambian Community Health Worker

Adrian Banda wears many hats: farmer, husband, father, headman of Kalinde Village in the Eastern Province of Zambia, and a volunteer community health worker. Many villagers live far from health facilities and lack a means of transportation to reach them. Frontline health workers like Adrian are often the first, and sometimes only, providers of health services essential to child and maternal survival, like diagnosing and treating malaria. "There are many people that, because of the distance to the hospital, would decide to not seek treatment or would have delayed treatment," Adrian said. "Having medicines and being able to test in the community has helped a lot."

Adrian cares for about 1,500 people in 11 nearby villages, diagnosing and treating common childhood illnesses and engaging in community health promotion. He attends to 15–20 people each day; most present with fever. When he started, the community did not know the signs of malaria or have the commodities they needed. "Now we are able to test and treat community members. We educate them on how to take the medicines, emphasizing on finishing the course."

PMI supports training for health workers, like Adrian, and procures and distributes RDTs and ACTs, so people can promptly access appropriate treatment (see Chapter 6 for more on PMI's efforts to ensure stock availability and respond to emergency orders). PMI's integrated community case management (iCCM) efforts are coordinated with the U.S. Agency for International Development's (USAID's) maternal and child health programs, as well as with support from other key partners, including UNICEF, WHO, and the Global Fund.

Adrian sees firsthand the impact of the availability of malaria prevention and treatment. Before PMI, "there were too many deaths and too much sickness," Adrian said. "People were unable to farm and find food. We spent a lot of time attending funerals and tending to sick people. I used to conduct about 30 malaria tests, and 27 would be positive for malaria. These days, it's the opposite. Out of 10 tests, you will find maybe 1 positive for malaria. This is a good sign that malaria is on the decline."

Spotlight on Partnerships: Improved Case Management

WHO

PMI continues to provide leadership in case management at the global level by contributing to key manuals and guidance and by participating in multi-stakeholder meetings to develop global recommendations. PMI contributed to development of the 2016 WHO Malaria Microscopy Quality Assurance manual and provided key evidence for the inclusion of a chapter on Outreach Training and Supportive Supervision as a best practice for maintaining high quality at scale. PMI staff also actively participated in the WHO Technical Expert Group on Drug Efficacy and Response and the Evidence Review Group on methods for field-based quality control of RDTs.

UNITAID and MMV

PMI worked closely with the UNITAID-funded, Medicines for Malaria Venture (MMV)-led initiative to strengthen implementation of pre-referral and definitive treatment of severe malaria in children. In 2016, much of this partnership centered on planning for the roll-out of rectal artesunate for pre-referral treatment of severe malaria in Africa. Currently, PMI procures this treatment for DRC, Ghana, Guinea, Senegal, and Zimbabwe. To prepare for this treatment modality's increase in use, MMV and PMI organized a stakeholder meeting in February 2016 to discuss best practices related to introducing rectal artesunate into countries, including strategies for behavior change communication, monitoring and evaluation, and training of health workers. Key conclusions from this meeting are being incorporated into policy documents, health worker training materials, and future research protocols. PMI has also provided input into the creation of MMV's Severe Malaria Observatory, an online resource providing updated guidance to the malaria community.

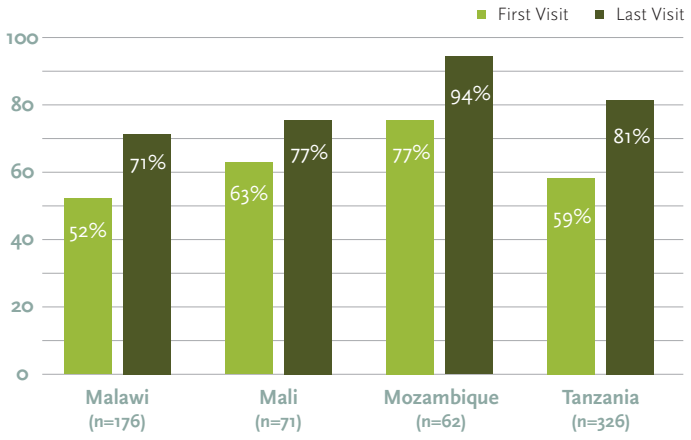
orientation of 682 graduating students to ensure that they were knowledgeable on the current guidelines upon entering the workforce. Malaria-related course content was revised by experts at Kamuzu College of Nursing to ensure that students in any stage of their course work would receive updated information. Key areas of revision included triaging, treating, and monitoring of severe malaria patients as well as inclusion of important steps such as recording RDT results in course clinical log books.

MAINTAINING AND EXPANDING QUALITY OF CASE MANAGEMENT THROUGH SUPERVISION

PMI support of training in diagnostics and treatment is complemented by support of routine supervision at health facilities, including the PMI-developed approach of OTSS visits by supervisors at the national, provincial, and district levels. These visits focus on jointly improving the quality of diagnostic testing by laboratory technicians and treatment practices by clinicians. OTSS incorporates on-site training, mentoring, and troubleshooting with routine supervision that assesses health worker performance through direct observation, facility and record review, and re-checking of blood slides. An electronic data system can improve the use of supervision checklists in the field and improve data compilation, analysis, and strategic use (see sidebar in Chapter 4, page 44). Across multiple countries, the OTSS platform supported by PMI has contributed to measureable increases in a number of key indicators, including performing a diagnostic test prior to administering an ACT (Figure 6, page 33) and not treating patients who have a negative test result with an ACT (Figure 7, page 33). Nearly all PMI focus countries are scaling up QA systems in case management, with six countries currently at national scale. Examples of supervision activities supported in FY 2016 include:

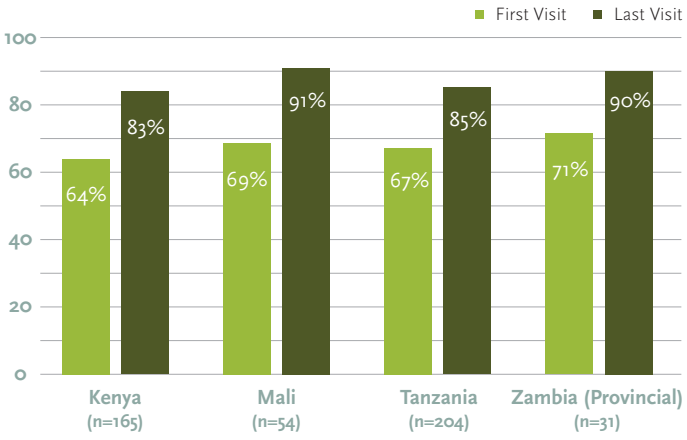
- In **Angola**, PMI has supported provincial and municipal health and laboratory staff to address the challenges of poor case management and patient record management at the health center level by conducting supervisory visits, reviewing health staff practices and reports, and supporting staff to improve malaria services. In Benguela Province, the improved capacity of provincial and municipal supervisors to conduct quality formative supervision since 2013 has resulted in a 14 percent increase in the number of health workers correctly using RDTs; 77 percent of workers are now correctly performing rapid diagnostic tests. There also has been a 19 percent improvement in differential diagnosis and a 21 percent improvement in health staff knowledge of when pregnant women should receive IPTp. Moreover, provincial and municipal health supervisors now have the capacity to conduct quality supervision with minimal support from partners.

Figure 6. Proportion of Health Facilities with Consistent OTSS Visits Meeting Minimum Standard of Competency (90 Percent) in Performing a Malaria Test Prior to Treatment with an ACT, by Country



*Note: Data presented is over 3 visits for Malawi and Mozambique and 2 visits for Mali and Tanzania.

Figure 7. Proportion of Health Facilities with Consistent OTSS Visits Meeting Minimum Standard of Competency (90 Percent) in Adherence to Negative Malaria Test Results, by Country



*Note: Data presented is for two visits for all facilities.

- In addition to supervisors using data collected on OTSS visits, staff at high-level, high-burden referral hospitals in **Kenya** and **Mozambique** are reviewing the information on their own to assist in facility-level decision-making. In Mozambique, 11 multidisciplinary malaria case management committees were established in reference health facilities in the high-burden provinces of Cabo Delgado, Nampula, Tete, and Zambezia with plans for extension to all 21 district reference facilities in Cabo Delgado and Tete Provinces in 2017. The committees meet monthly to review OTSS results and devise actions to close gaps that are identified. In Kenya, OTSS data is reviewed by health management therapeutics committees established in five county reference hospitals, and support will expand to cover committees in the three additional high malaria burden counties in 2017. These committees use the OTSS data to make decisions and policies to improve case management processes in their facilities, such as revising hospital register forms to better align with and reinforce adherence to national treatment guidelines.

- In **Madagascar**, nine supervisors from the NMCP completed OTSS trainings, and organized additional trainings in Antananarivo. PMI conducted a second round of joint laboratory/clinical OTSS in 24 basic health centers throughout the country to strengthen the health center supervisors' ability to conduct trainings and mentorship, in anticipation of a nationwide OTSS roll-out.

- In **Zambia**, low-performing and high volume facilities have been targeted with OTSS in four provinces to strengthen case management. After the most recent round of OTSS, there was a 19 percent increase in provider adherence to negative test results (from 71 percent to 90 percent). OTSS also contributed to improvements in RDT and microscopy performance, with 90 percent and 100 percent of district facilities meeting minimum technical competencies in these diagnostic tests, respectively, after the most recent round.

Morgana Wingard, USAID

3. Adapting to Changing Epidemiology and Incorporating New Tools

With the scale-up of malaria control interventions and subsequent reductions in malaria mortality and morbidity, some U.S. President's Malaria Initiative (PMI) focus countries have adopted more targeted approaches to further optimize malaria control, with strategies that focus control activities at the subnational level or target specific population groups. In some countries, reductions in morbidity and mortality have led national malaria control programs (NMCPs) to set long-term goals of malaria elimination (see Chapter 1). PMI is supporting countries as they roll out such targeted interventions and, where appropriate, supporting activities that aim to move countries closer to malaria elimination. PMI also is investing in evaluating the effectiveness and feasibility of new tools and approaches and supporting operational research to improve scale-up and maximize the impact of existing interventions.

ENHANCED CASE FINDING AND INVESTIGATION

As countries move toward elimination, detecting, tracking, and following up every malaria case becomes an important tool toward interrupting malaria transmission and identifying residual foci of transmission. For example, PMI is supporting pilots of reactive case detection in areas of **Cambodia, Senegal,** and **Zanzibar** that are targeted for elimination. PMI is also testing other malaria transmission reduction strategies by actively identifying fever cases in the community and providing testing and treatment for malaria, as appropriate.

Highlights from FY 2016 include the following:

- In Sampov Loun Operational District in **Cambodia**, a strategy of case reporting, investigation, and response, using the "1-3-7" approach is being implemented with PMI's support (see Sidebar, page 36). The objectives of this approach are as follows: (1) every diagnosed malaria case should be notified to district-level health authorities within 1 day; (2) an investigation of that case, including determining whether the case was locally-acquired or imported, should be conducted within 3 days; and (3) a response, which includes testing household contacts of the case as well as fellow travelers (for imported cases), and residents of neighboring households with fever, should be completed within 7 days. Within the first 3 months of implementation, more than 80 percent of all cases were reported and investigated, and a response carried out within the given timeframe. As of September 2016, these activities had been carried out within the "1-3-7" timeframe in 100 percent of all new malaria cases (see Figure 1, page 37). The investigations identified that only 14 of 127 villages reported locally-acquired cases, many of which were acquired when residents slept overnight on their farms (which were located away from their homes). Response activities identified only 11 additional malaria cases during the 15-month period, all of whom were fellow travelers of imported cases. Further investigations of the 14 villages with ongoing transmission are underway.

- In **Senegal**, PMI collaborated with the Peace Corps and NMCP staff to scale up the proactive community treatment (ProACT) program, which consists of weekly visits to every household in targeted communities in moderate prevalence areas during the transmission season to identify and test fever cases and provide treatment to those testing positive for malaria. In 2015, ProACT was implemented in 246 villages in Kedougou and Kolda regions. During active sweeps, 21,915 people with fever were tested and 15,068 were found to have malaria, of which 14,388 were treated with artemisinin-based combination therapies (ACTs) in their communities. The others were referred to a health facility because they presented with danger signs or due to a lack of ACTs at the community level. Access to malaria diagnosis and treatment at the community level has improved with an increased number of people

Implementing the "1-3-7" Approach for Malaria Elimination in Cambodia

Sampov Loun Operational District is located along the Cambodian-Thai border where malaria drug resistance has been documented. While the district has historically experienced a heavy malaria burden, confirmed malaria cases have declined to 450 cases in 2014. The district has, therefore, shifted from malaria control to malaria elimination.

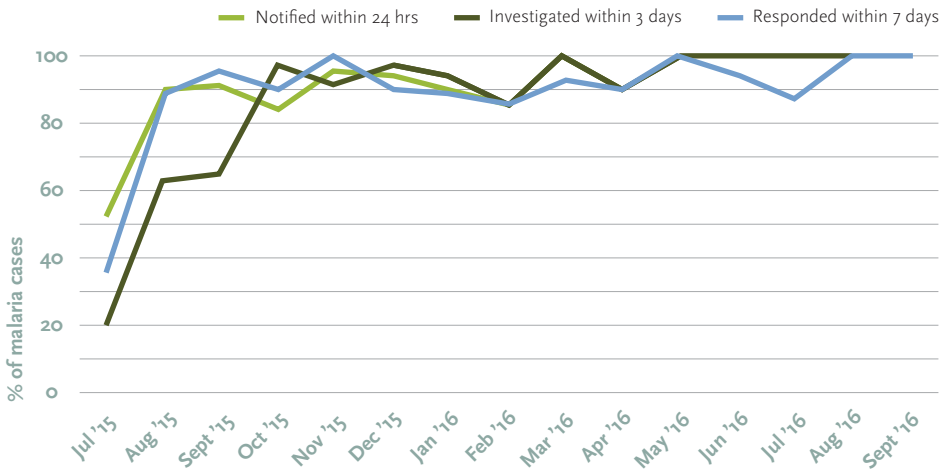
In close consultation with PMI and the National Centre for Parasitology, Entomology, and Malaria, a basic essential package of activities for malaria pre-elimination using the "1-3-7" surveillance approach was designed for piloting in this district. This approach requires that all confirmed malaria cases are reported to district health authorities within 1 day, that cases are investigated within 3 days, and that follow-up actions are taken within 7 days. Prior to the launch of the program in June 2015, all implementers including district and health center staff and village malaria workers were oriented and trained on the approach with PMI's support.

This new approach has resulted in a significantly more intensive workload on health workers, given the need to notify, investigate, and respond to all cases within a specified timeframe and provide follow-up visits to patients with *P. falciparum* and mixed infections 28 days after treatment.

While PMI's implementing partner staff initially spearheaded activities, leadership for activities transitioned to district and health center staff within 6 months, and ownership for elimination activities now rests entirely with the district team. When district staff are notified of a case by a village malaria worker, the district and health center staff immediately communicate to schedule a case investigation and follow-up interventions.

Mr. Om Bunthy, the district's Malaria Supervisor, is a motivated contributor to the elimination approach and has supported and guided implementation of activities since the beginning. He stated that "the essential package of activities for malaria elimination has changed the way we work. When we became involved in pre-elimination activities, we began to pay close attention and follow through on a lot of initiatives. Furthermore, we have learned new things, including how to perform indoor residual spraying and analyze case classification [indigenous/locally transmitted or imported cases]."

Figure 1. Results of Surveillance and Response Activities in Sampov Loun, Cambodia (July 2015–September 2016)



Source: University Research Co.,LLC, Control and Prevention Malaria (CAP-Malaria) Project.

being appropriately tested, treated, and referred as needed, ensuring a better outcome. The number of malaria cases diagnosed at the community level in these two regions has increased from 5,354 in 2013, to 16,560 in 2014, and to 27,929 in 2015. In 2016, ProACT was further expanded to two additional regions (Sedhiou and Tambacounda), in a total of 702 villages. Analysis of the data collected during 2016 is underway. PMI is supporting a study of a similar program in **Madagascar** in the moderate-transmission district of Mananjary through a partnership between the NMCP, the Peace Corps, the Pasteur Institute of Madagascar, and local communities.

INCORPORATING NEW TOOLS AND APPROACHES

Achieving the long-term global vision of a world without malaria will require innovative approaches to improve the coverage of existing interventions as well as new tools. PMI remains committed to supporting research to evaluate new tools and new implementation approaches and to answering key operational research questions in cooperation with research partners around the globe.

Evaluating new vector control tools to address insecticide resistance

In **Malawi**, increasing levels of pyrethroid resistance among malaria vectors is a potential threat to the effectiveness of insecticide-treated nets. With PMI support, a local non-governmental organization distributed pyrethroid-synergist nets, which include a second active ingredient to overcome one mechanism of mosquito resistance to pyrethroids in two districts during the country's 2016 mass insecticide-treated net (ITN) distribution campaign. As part of PMI's commitment to evaluating promising tools, the Malawi program adjusted its standard entomological monitoring program to include these districts to facilitate the comparison of the impact of pyrethroid-synergist nets against districts where standard pyrethroid nets were distributed. The results of this monitoring activity will add to the body of evidence regarding the efficacy of pyrethroid-synergist nets and decisions about whether and when to bring these nets to scale.

Using digital technology tools to improve implementation

In **Benin**, Peace Corps volunteers developed an application on an open-source digital platform called CommCare to help streamline an ITN needs assessment and community-based distribution. Following a 1-day training, 10 teams of trained local counterparts and Peace Corps volunteers conducted needs assessments in an urban community. Using a house-to-house approach, the teams surveyed 1,478 households, representing a total population of 9,681 people. Based on the number of household members and the number of ITNs per household, the application calculated the number of nets needed by household. In addition to procuring the ITNs and funding their distribution, PMI provided extensive guidance on the data collection parameters, which were then incorporated into the application. Nets were subsequently

Spotlight on Partnerships: Vector Control

PMI staff provide technical input on targeting interventions and insecticide resistance monitoring. In addition, PMI contributes insecticide resistance data into the WHO Global Insecticide Resistance database and to the *World Malaria Report*. This ongoing engagement ensures that PMI-funded research and ongoing monitoring and evaluation of field activities continue to inform global and national malaria prevention policies and ensures that state-of-the-art practices have the full endorsement and backing of the global community.

During FY 2016, PMI, along with the Bill & Melinda Gates Foundation and other global organizations, continued to play a key role in the Innovation to Impact (I2I) partnership, informing a process to transition the evaluation of vector control products to a system that more readily fosters innovation, effectiveness, efficiency, and quality assurance.

provided to each household at various distribution locations. The application improved data quality by removing the potential for human error that can occur when transferring data from paper to a digital format. Furthermore, CommCare improved the speed and accuracy of the distribution process by automatically matching names against phone numbers, verifying that correct quantities of nets were distributed to each household, and allowing for real-time tracking of ITN stocks at the various distribution points. Based on the successful deployment of CommCare in Benin, it has become the standard tool that Peace Corps volunteers use for targeted household ITN distributions.

In **Ghana**, PMI collaborated with Leti Arts, a game development studio, to create an interactive malaria story application called Hello Nurse. This mobile learning platform reinforces concepts around malaria case management and prevention and is being rolled out as a tool to supplement classroom-based learning in 38 midwifery and 12 community health nursing schools. The application is an alternative learning platform that seeks to help providers retain key concepts and apply them in a real-life situation. For example, Hello Nurse includes a scenario in which the healthcare provider interacts with a pregnant woman and is required to provide advice and education to reinforce prevention of malaria in pregnancy messages.

Enhancing health worker job aids to improve performance

In **Mozambique** and **Madagascar**, PMI and the USAID Maternal Health Team developed and field tested a visual job aid to help providers identify early second trimester pregnancies to support the administration of the first dose of intermittent preventive treatment for pregnant women (IPTp) during focused antenatal care (ANC) visits. This simple job aid incorporates research on precise gestational age estimation and includes algorithms and decision support tools. Accurately estimating gestational age is needed for the correct implementation of WHO IPTp guidelines. Finalization of the tool is currently underway.

Developing innovative outreach approaches to improve IPTp coverage

In **Nigeria**, PMI supported the implementation of outreach services that helped health facility health workers to deliver IPTp services to women in communities with very low ANC attendance in two states (Kebbi and Zamfara). The strategy included using color-coded cards to track women who were given IPTp (including the number of doses received) and referred from the communities to the primary healthcare centers. These cards served both as appointment reminders for pregnant women and as an aid for health workers to track the number of IPTp treatments received by each woman. Monitoring data have shown a significant increase in ANC attendance in these two states, and 22,577 women received at least one dose of IPTp during the 6 months of the pilot.

Conducting operational research to improve intervention coverage and impact

PMI-supported operational research complements the U.S. Government's investments in upstream malaria research (e.g., basic research and new tool development), which is carried out by the U.S. Centers for Disease Control and Prevention (CDC), the U.S. Agency for International Development (USAID), the National Institutes of Health (NIH), and the Department of Defense. In line with PMI's Strategy for 2015–2020, operational research supported by PMI addresses bottlenecks in achieving and maintaining coverage of proven interventions, while also informing malaria control efforts as malaria epidemiology changes, new

risks and challenges arise, and new tools are introduced to combat them. PMI-funded studies are implemented in collaboration with NMCPs and institutions within PMI focus countries, thus strengthening in-country capacity to undertake research. PMI resources support research questions that are important and relevant to achieving PMI's strategic objectives. To date, PMI has funded 102 operational research studies and contributed to more than 200 peer-reviewed publications (visit http://pmi.gov/how-we-work/cross-cutting-technical-areas/operations-research for details).

Operational research highlights from FY 2016 include:

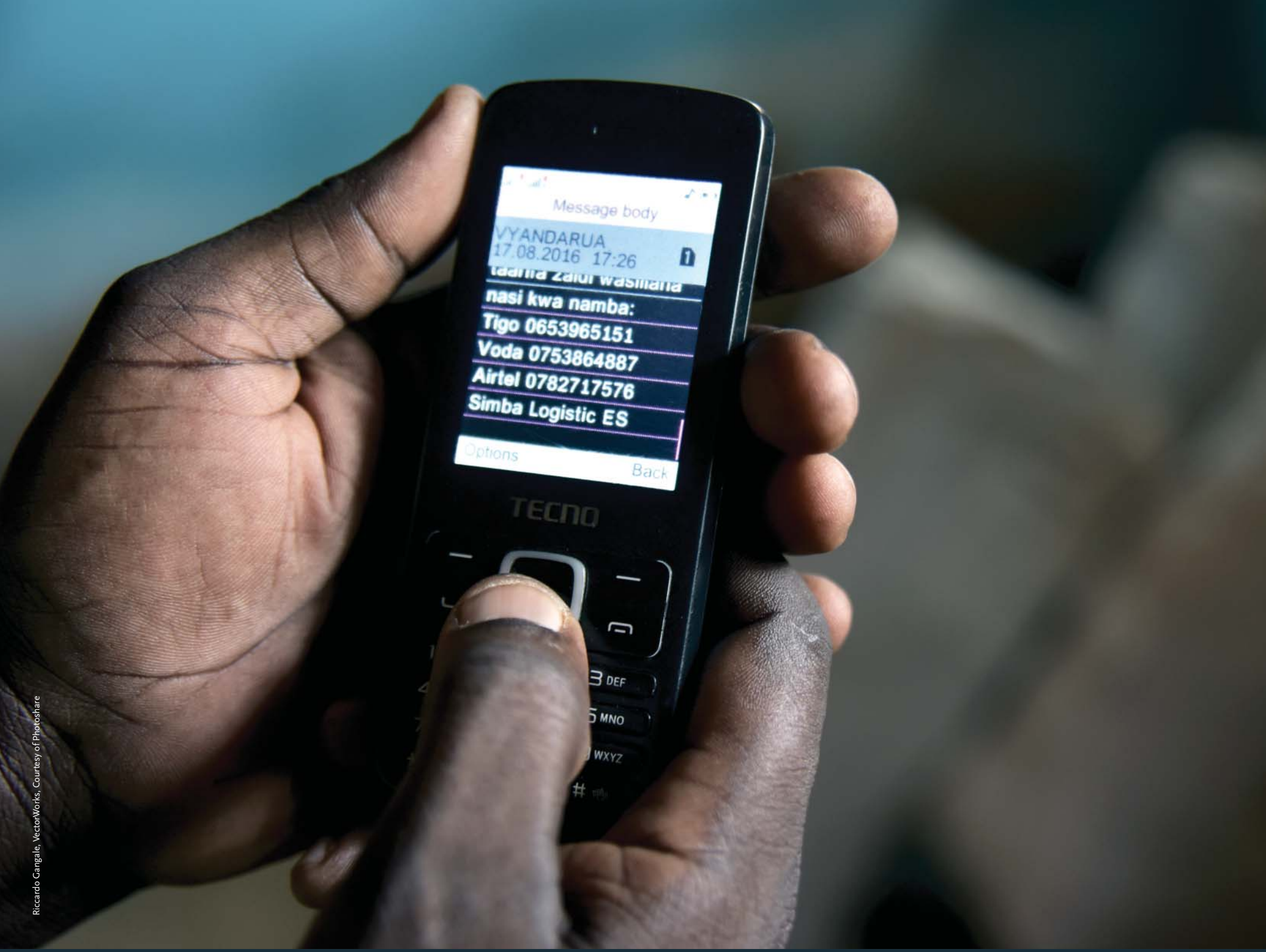
- In **Burma**, PMI-supported research found high acceptability of insecticide-treated clothing among rubber tappers, a group at high risk of malaria infection in the region. Preliminary results have been shared with national and township level ministry of health and malaria staff. Prior to wide-scale implementation, results on cost-effectiveness and potential financing mechanisms, as well as efficacy and effectiveness of insecticide-treated clothing in field settings, will need to be gathered through further research.

- Single, low-dose primaquine is recommended by WHO to help reduce the transmission of *P. falciparum* parasites in areas moving toward elimination and also in settings where artemisinin-resistant parasites have been identified. Because glucose 6 phosphate dehydrogenase (G6PD) deficiency, which is prevalent in the **Greater Mekong Subregion**, can lead to life-threatening side effects associated with higher dose primaquine use, PMI supported an operational research study in **Cambodia** to assess the safety and tolerability of single, low-dose primaquine in G6PD deficient patients and non-deficient patients with uncomplicated *P. falciparum* infections. The results of the study, which indicated that low-dose primaquine is sufficiently safe to administer to all patients regardless of G6PD status, has led the national malaria control program to adopt a new policy recommending single, low-dose primaquine for all patients diagnosed with *P. falciparum* without G6PD testing in elimination areas. PMI will support the pilot implementation of this new policy, coupled with monitoring for adverse reactions.

- As gains in malaria prevention and control have led to a reduction in malaria cases across many parts of sub-Saharan Africa, the proportion of non-malaria fevers seen by health workers has increased. PMI has supported operations research in the **Democratic Republic of the Congo (DRC)** and **Ethiopia** to investigate whether algorithms for the management of non-malarial fevers by community health workers who conduct integrated community case management could be simplified. Results from these studies, available in early 2017, will help to inform policies that reduce the burden on both caregivers and health workers, while maintaining the same high level of positive health outcomes in children.

- In **Madagascar**, PMI supported a qualitative study to assess ITN ownership and use in four districts in four malaria epidemiologic zones of the country: Ambovombe, Farafangana, Morondava, and Sambava. The findings of this study identified barriers to bednet use and highlighted the importance of translating messages into local languages. These results were incorporated into the development of the country's new social and behavior change communication strategy and will inform the new NMCP strategic plan.

- PMI is supporting multiple studies to assess how to improve the coverage of IPTp with sulfadoxine-pyrimethaine (SP). For example, one approach under evaluation is the distribution of SP by community health volunteers. While this strategy may improve the ability to deliver more doses of SP, there is the potential concern that it might result in lower ANC attendance. PMI is conducting operational research studies in **Malawi** in order to assess the feasibility of this approach, as well as the impact on both IPTp coverage and ANC attendance. These studies will add to the broader evidence base regarding the effectiveness of community-based distribution of IPTp in different settings and have implications for policy recommendations on community IPTp.



Riccardo Gangale, VectorWorks, Courtesy of Photoshare

4. Improving Countries' Capacity to Collect and Use Information

Since its launch, the U.S. President's Malaria Initiative (PMI) has prioritized collecting data to monitor the coverage and impact of key malaria interventions and supporting countries to use these data to guide program planning and implementation as well as inform malaria-related policies. This is in line with the Global Technical Strategy pillar of transforming surveillance into a core malaria intervention.

PMI provides support for a broad set of malaria data collection efforts across PMI focus countries. These include support for nationwide household surveys, routine health management systems, entomological monitoring, therapeutic efficacy monitoring, and supply chain related surveys of malaria commodities. Household surveys have demonstrated that all-cause child mortality, to which malaria is a major contributor, has seen a substantial reduction across PMI focus countries (see Chapter 1). With this drop in the burden of malaria, countries' control efforts need to be increasingly targeted geographically in order to quickly respond to gaps in intervention coverage and potential epidemics. The rapidly changing malaria landscape demands that country programs be responsive and dynamic, and to accomplish this, it is imperative that they have access to reliable and timely data to take prompt and informed decisions.

ROUTINE HEALTH MANAGEMENT INFORMATION SYSTEMS

Leveraging online platforms: District Health Information System – Version 2

PMI continues to strengthen surveillance in focus countries through increasing investments to support health management information systems (HMIS). PMI's support for the collection and use of HMIS data is critical to improving the capacity of national malaria control programs (NMCPs) to monitor progress, respond to outbreaks, and rapidly adapt to changes in the epidemiology of malaria.

A major limitation of HMIS has been a reliance on paper forms, which have many disadvantages. Numerous person-hours are required to transcribe data from the paper forms into electronic databases. Furthermore, the time and expense required to physically transport paper forms from one location to another is significant. Over the past decade, there has been tremendous growth and uptake of the District Health Information System – Version 2 (DHIS-2), a robust, open-source electronic health information platform that is now implemented in more than 60 countries worldwide. The transition from paper-based HMIS reporting to electronic data platforms using DHIS-2 has improved the completeness, timeliness, and validity of HMIS data, making these data more reliable and accessible.

With PMI's support, there has been significant uptake of DHIS-2 across PMI focus countries. To date, 16 of the 19 PMI focus countries in Africa have fully transitioned their HMIS system to the DHIS-2 platform, or are in the process of transitioning. PMI is supporting this transition through trainings and data review meetings at national and sub-national levels to further increase the usability of HMIS data. There is considerable variation across countries; while a few programs are moving to develop individual case reporting and investigation systems or are using mobile devices for electronic reporting from the point of care, most countries are focused on increasing aggregate case reporting on the DHIS-2 platform and improving aggregate data management and use at the national and regional level. Similarly, the capacity to use these data varies widely within and across countries.

The following are examples of PMI-supported data collection activities:

- In **Nigeria**, the country with the highest malaria burden in Africa, malaria data are essential for monitoring and evaluating impact. However, paper-based systems have slowed down

Spotlight on Partnerships: U.S. Department of Defense

PMI benefits from expertise in entomology from the U.S. Navy, which provides subject matter expertise in vector control and insecticide resistance management at both the country level and at PMI headquarters. Navy entomology staff provide support for PMI activities in Ghana, Rwanda, and Uganda.

In Ghana, for example, the U.S. Department of Defense entomologist has been providing support since 2007. This has included conducting field and laboratory investigations to understand the relationships between chemical and biological assays to determine the effectiveness of IRS, providing direct support to field sites during IRS operations, and initiating and directing field evaluations of novel IRS insecticides, the results of which have helped set IRS policy for Ghana and other countries in sub-Saharan Africa. In Uganda, the Navy entomologist also provides critical assistance to NMCP staff, district and state vector control officers, and other public health entities with insecticide resistance monitoring site selection, hands-on training with the U.S. Centers for Disease Control and Prevention insecticide resistance intensity bioassay and resistance mechanism techniques, recommendations on insectary development, and writing and reviewing reports and training manuals.

routine collection and processing of data. In Ebonyi State alone, one of the PMI-supported states, the sheer volume of data from its 550 facilities made the local monitoring and evaluation officer's work difficult and time consuming, restricting the state from performing further analyses and using the data to inform program planning. With PMI funding, the State Malaria Elimination Program deployed routine consultative data meetings to facilitate collection and collation of data into the nationally-harmonized HMIS using DHIS-2. The DHIS-2 implementation required training of government staff at all levels, close supervision, and considerable data quality checks. The effort, according to state authorities, was well worth the investment. Reporting rates from health facilities went from 28 percent in 2013 to 89 percent in 2016, and these data are now used to inform planning of malaria activities. For example, these data are compared with Logistics Management Information System data to identify and investigate discrepancies between numbers of reported malaria cases and quantities of artemisinin-based combination therapies (ACTs) consumed. In addition to Ebonyi State, eight other states supported by PMI have now deployed DHIS-2. Malaria data are now more accessible, and overall reporting rates are higher in PMI-supported states as compared to the national average.

- In **Mali**, data on malaria cases and deaths were derived from the *Système Local d'Information Sanitaire* (SLIS). Like HMIS in other countries, the quality and timeliness of these data were highly variable, and the data were not reported directly to the NMCP. Since PMI launched in Mali in 2008, it has supported enhancements to the malaria reporting component of the SLIS. These enhancements include updated indicators and improved data transmission tools, such as short messaging systems. The SLIS also now includes a summary page of malaria data and case reports that are sent directly to the NMCP. In 2015, PMI, the U.S. Agency for International Development (USAID), and other donors began investing more broadly in the DHIS-2 platform for HMIS, in the hopes of alleviating several of the data quality challenges of the SLIS. PMI support focused on integrating the malaria page into the new DHIS-2 platform and funding expansion to all regions of Mali. As of December 2016, most regions in Mali were already reporting more than 70 percent completeness on the DHIS-2 platform. The transition to this system, even in a relatively unstable political environment, has been swift and comprehensive. The NMCP anticipates having close to 100 percent completeness of data reporting by the first quarter of 2017. These malaria-specific data are now being used to inform targeting and planning of malaria prevention and control activities.

COLLECTING AND USING HOUSEHOLD SURVEY DATA

PMI provides support for nationwide household surveys, which are conducted approximately every 3 years to monitor changes in coverage of key malaria control interventions (such as insecticide-treated net [ITN] ownership and use) and to measure impact, particularly all-cause child mortality in children under five years of age, malaria parasitemia, and anemia. Since PMI's launch in 2005, 80 nationally representative household surveys across the 19 focus countries in Africa have been conducted with PMI's support. These surveys have provided essential information that has

Pearl Gan, OUCRU, EORCU and the Wellcome Trust

Eliminating Malaria in Thailand: The Need for a Single National Malaria Information System

Thailand has made great progress in combating malaria and is moving closer to its goal of national malaria elimination. An important precursor to achieving this is a national malaria surveillance system capable of early detection, treatment, and follow-up for every malaria case in real time. This type of system must also have the ability to provide evidence for policy reform by capturing the overall status of the national malaria program in easily understood formats.

In 2009, Thailand replaced its paper-based surveillance system with an electronic management information system that was developed by the Center of Excellence for Biomedical and Public Health Informatics.

However, instead of one streamlined system, Thailand's malaria program structure led to the creation of two surveillance systems: (1) a vertical system run by malaria clinics and malaria posts that reports promptly to the Bureau of Vector Borne Diseases (BVBD) and (2) a second system managed by the General Health Service, which reports weekly to the Bureau of Epidemiology.

The use of two reporting channels with disparate variables between systems has resulted in gaps and duplication of data that undermine the functional response to malaria outbreaks and case follow-up. With support from PMI, Thailand's BVBD has developed a new software application that consolidates data from the vertical system with the General Health Service's system into a single surveillance system.

Dr. Prayuth Sudathip, Head of the Center for Malaria Elimination Coordination at the BVBD, noted that "the electronic database integration is critically valuable for achieving malaria elimination in Thailand. There will need to be more trainings to build local capacity [of] the government-based information technology personnel for continuous improvement in malaria surveillance and program implementation." It is anticipated that by the end of 2017, the BVBD will be capable of detecting, treating, and tracking every malaria case reported in Thailand. This will enhance Thailand's ability to target interventions and resources where they are most needed.

ELECTRONIC DATA SYSTEM IN GHANA IMPROVES OUTREACH TRAINING AND SUPPORTIVE SUPERVISION

A key component of PMI's case management support to Ghana's National Malaria Control Program is the provision of outreach training and supportive supervision (OTSS) at health facilities (see Chapter 2).

To help collect standardized information and better assess health facility performance over time, PMI supported the introduction of a checklist that is completed by supervisors during their OTSS visits. At first, OTSS visits were conducted using paper-based checklists; however, the time required for manual data entry and compilation of aggregate facility data through a centralized database led to delays in analysis and action. To help provide supervisors and other decision-makers with timely access to quality data, PMI supported the development and introduction of an electronic data system (EDS).

Some key features of the EDS include:

- ***Automatically generated scores:*** **After completing an observation, supervisors can easily review scores on each module and overall help assess the healthcare worker's performance and give immediate feedback.**
- ***Real-time data review:*** **Once entered and sent automatically via any available network, data are immediately available in the online DHIS-2 platform for review by Ministry of Health staff located around the country, from the district up to the national level.**
- ***Data storage for tracking facilities over time:*** **Once an assessment has been submitted, the data are stored, and this enables supervisors to track the progress of individual health workers and facilities over time at subsequent visits.**

In Ghana, a total of 685 supervisors from the 5 regions have been trained with PMI's support on the use of EDS to conduct 2 rounds of OTSS, which reached 1,937 facilities in 107 districts. Performance of facilities and staff can now be easily and quickly tracked over time as compared to the previous paper-based approach.

Adoption of the EDS has enabled hundreds of supervisors to analyze their own data at the provincial, district, and even facility level. Low-performing facilities can be targeted for additional rounds of OTSS, and supervisors can identify which critical steps need additional mentoring to improve a given facility's performance.

Based on the success of the EDS so far, ministries of health in other PMI focus countries, including Malawi and Tanzania, are planning to adopt the electronic platform for health worker supervision and expand its use to additional regions.

confirmed progress in both scaling up coverage of key interventions and significantly reducing all-cause child mortality (see Appendix 3). In addition, through its support for these surveys, PMI is also building capacities within ministries of health, national statistics bureaus/agencies, and research organizations to manage surveys as well as collect, analyze, and use survey data.

MONITORING MALARIA CONTROL INTERVENTIONS

In addition to monitoring impact and coverage of interventions, PMI also monitors entomological indices, drug and commodity stock levels, therapeutic efficacy of malaria treatments (see Chapter 5), and performance of health workers and laboratory staff through electronic data systems (see Chapter 2).

Entomological monitoring

Entomological monitoring helps to inform vector control programs by providing data on the species composition, abundance, distribution, and behavior of the vectors that transmit malaria, their longevity, and the proportion that are infected. Entomological monitoring also serves to track the quality of vector control interventions, the residual

bio-efficacy of insecticides used for indoor residual spraying (IRS) or incorporated into long-lasting ITNs, the susceptibility of malaria vectors to these insecticides, and the impact of vector control interventions. PMI's investments have resulted in a substantial improvement in the capacity of PMI focus countries to implement entomological monitoring. All 19 PMI focus countries in Africa conduct regular entomological monitoring with PMI support.

For example, during FY 2016:

- PMI organized two entomological trainings (in **Senegal** and **Zimbabwe**) for junior NMCP and other government counterpart staff to ensure that comprehensive, standardized, and high quality entomological data are collected and to ensure the sustainability of entomological data collection by NMCPs. Staff from 18 PMI focus countries participated in the trainings, which focused on the basics of collection, analysis, interpretation, dissemination, and use of entomological data, complementing the more advanced regional trainings held last year.

- PMI supported a South-South collaboration by sending three Ministry of Health staff from the **Democratic Republic of the Congo (DRC)** to participate in a 3-month training on entomology and public health at the *Centre de Recherche Entomologique de Cotonou* in **Benin** that covered both field and laboratory techniques for evaluating vector control interventions. Furthermore, PMI helped to support regional capacity building and trainings in the Greater Mekong Subregion (GMS) on vector control for NMCPs, which included 50 participants from 12 countries (from both PMI and non-PMI focus countries).

- In seven countries, PMI has supported the rollout of entomological monitoring databases using the Disease Data Management System developed by the Liverpool School of Tropical Medicine and the Innovative Vector Control Consortium. These databases will enable the compilation of historical as well as current and future entomology data in order to drive decision-making around vector control interventions. In FY 2016, PMI supported installation of this database in **Madagascar, Mozambique,** and **Zimbabwe**.

- In **Guinea**, PMI provided technical assistance for entomological monitoring throughout the year in four sentinel sites in the regions of Boke, Labe, Kissadougou, Kankan, and an additional site in Maferinya sub-prefecture. In addition, PMI supported the establishment of the first insectary at the Gamal Abdel Nasser University in Conakry, with the goal of improving entomological monitoring and local training capacity.

End-use verification surveys for malaria commodities

PMI implements end-use verification (EUV) surveys in PMI focus countries to monitor the availability of malaria commodities in health facilities. Information on ACT, rapid diagnostic test (RDT), sulfadoxine-pyrimethamine (SP), severe malaria medicines, and ITN stocks in warehouses and associated health facilities is collected to identify and rapidly address stockouts and also to uncover localized weaknesses in the supply chain that require additional support. The majority of PMI focus countries conduct EUV surveys in a sample of health facilities on a quarterly or biannual basis. To date, PMI, in collaboration with government counterparts, has conducted 221 EUV surveys (26 in the past fiscal year) in a total of 16 PMI focus countries. For example:

- In **Angola**, 11 rounds of EUV surveys have been conducted since 2010. Since the EUV surveys began, most provincial warehouses have improved storage conditions for commodities and are using good warehousing practices. The survey team has worked with technical staff to build capacity in pharmaceutical management, and as a result, municipal and provincial health leaders are using the final recommendations from the EUV surveys to strengthen the pharmaceutical system and case management. For example, the availability of stock cards has improved, and health facilities at the provincial level are now using these to track their malaria commodity stocks more closely.

- In **Ethiopia**, PMI has supported 19 EUVs since 2009. Immediate actions have been taken as a result of the EUV surveys including facilitating resupply of antimalarial drugs from supply stores to health facilities and facilitating stock transfers from health facilities with an overstock of antimalarial drugs to those that are understocked or stocked out. Health facility staff have been mentored on how to maintain and update inventory control cards, how to properly store medicines, and how to quantify the demands in order to place resupply orders. In 2016, the EUV demonstrated that 100 percent of health facilities visited were submitting malaria commodity stock status reports on time.

Riccardo Gangale

5 . Mitigating Risk against the Current Malaria Control Gains

DETECTING AND RESPONDING TO INSECTICIDE RESISTANCE

Insecticide-treated nets (ITNs) and indoor residual spraying (IRS) both rely on a limited number of World Health Organization (WHO) recommended insecticides from only four insecticide classes. Only one class – pyrethroids – is currently available for use in ITNs. When countries scale up their ITN and IRS programs, this places increased insecticide selection pressure on mosquito populations, which can accelerate the development, selection, and spread of vector resistance to insecticides. Furthermore, selection pressure from agricultural insecticide use, which is often in the same rural areas where malaria transmission is highest, can also increase insecticide resistance in mosquitoes. National programs need to conduct entomological monitoring, including testing for the presence and intensity of insecticide resistance, and to develop resistance management strategies. For example, during FY 2016, the U.S. President's Malaria Initiative (PMI) supported **Ethiopia** to develop and finalize a vector control strategy and implementation plan to guide the Federal Ministry of Health in insecticide resistance management.

Across PMI focus countries, insecticide resistance is monitored at approximately 190 sites, of which 85 percent have reported emerging or confirmed resistance to one or more pyrethroid insecticides. Although resistance can vary in frequency and intensity across multiple sites in a given country, vector resistance to pyrethroids has now been detected in all 19 PMI focus countries and resistance to carbamate insecticides in 16 PMI focus countries in Africa. Monitoring intensity, rather than mere presence, of resistance is critical. In order to determine the areas with the strongest resistance, which are higher priorities for resistance management, PMI is now supporting pyrethroid resistance intensity assays, which were rolled out in nine countries (**Democratic Republic of the Congo [DRC], Ghana, Kenya, Madagascar, Mali, Mozambique, Nigeria, Tanzania,** and **Zambia**). Confirmed resistance to pirimiphos-methyl, an organophosphate, was detected for the first time in FY 2016 in **Tanzania** in an area that has never received IRS. The emergence of insecticide resistance has prompted changes in insecticides used for IRS in the 12 PMI focus countries that have spray programs. In FY 2016, all PMI-supported IRS activities were conducted using a long-lasting organophosphate insecticide.

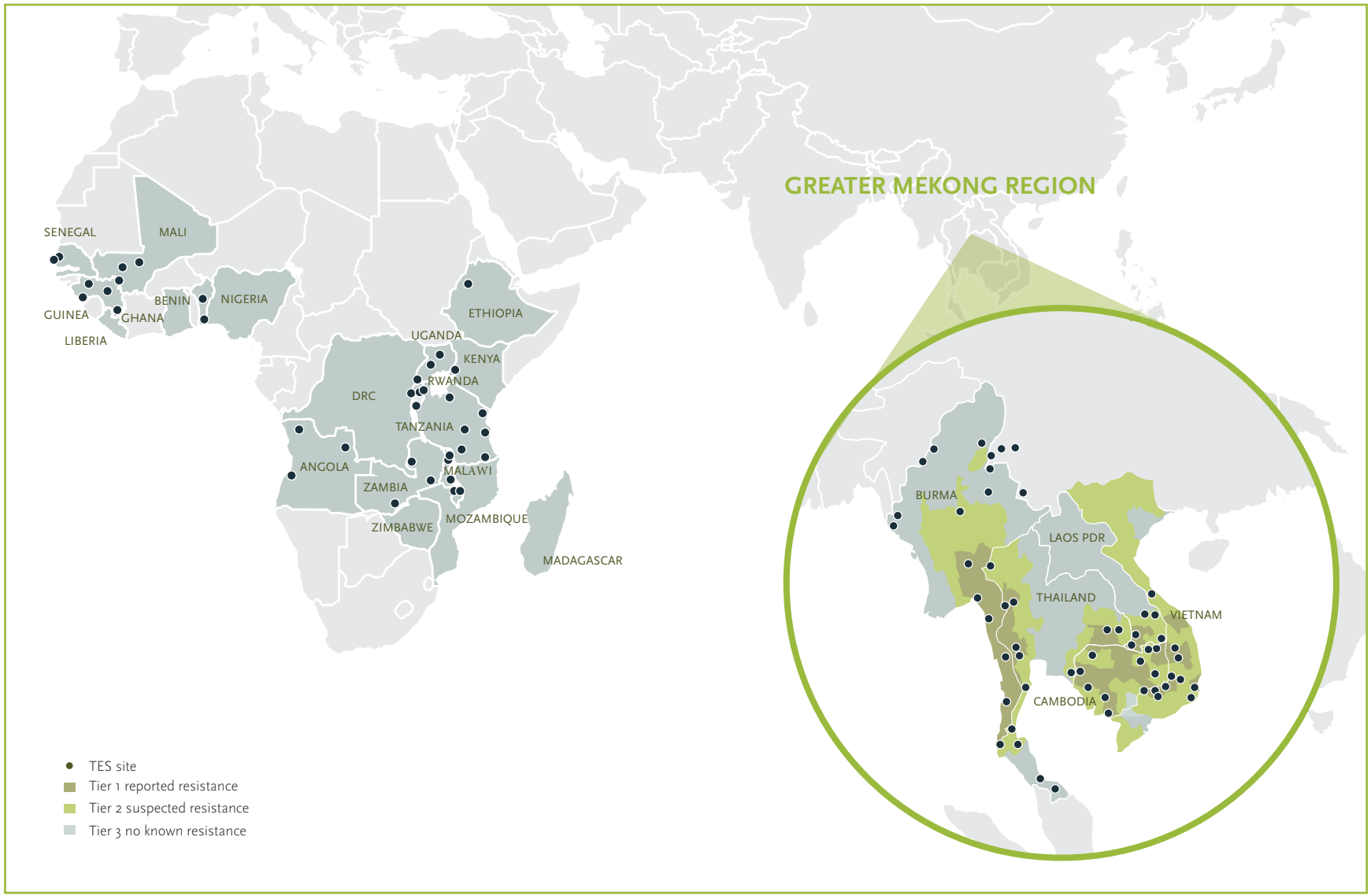
In 2016, WHO released the results from a multi-country evaluation to understand the performance of ITNs in context of pyrethroid resistance.[1] The evaluation found that ITNs continue to provide personal protection even in the face of resistance, confirming published results from other studies. However, there was some evidence of the loss of community protection in areas with higher resistance intensity. To mitigate emerging resistance, major global efforts are presently underway to develop and evaluate ITNs that contain mixtures of pyrethroid and alternative class residual insecticides with distinct modes of action. PMI continues to monitor the physical durability and insecticide retention of ITNs and plans to evaluate these dual action nets once they are recommended by WHO and deployed in countries where known pyrethroid resistance is intense.

MONITORING ITN DURABILITY

The current global recommendation is to replace ITNs every 3 years. However, studies conducted by PMI have shown that ITNs may physically deteriorate more quickly under certain field conditions and that ITN longevity is

1 Visit http://www.who.int/malaria/news/2016/iir-malaria-vector-control-evaluation-nov2016.pdf?ua=1.

Figure 1. PMI and Partner-funded TES Sites Reporting Molecular Drug Resistance Data, 2014–2016



strongly dependent on behavioral and environmental conditions, factors that vary significantly across malaria-affected areas worldwide. The studies that PMI supported in nine countries (**Angola, Benin, Kenya, Malawi, Mozambique, Nigeria, Rwanda, Senegal,** and **Zambia**) demonstrated that the physical durability of nets was highly variable from country to country, with some countries showing significant physical net deterioration in as little as 2 years.

PMI used the lessons learned from these studies to develop a standardized methodology for monitoring ITN durability and allowing for comparisons across all countries. Durability monitoring may be undertaken using a cohort of ITNs from a recent mass distribution campaign. In FY 2016, PMI's implementation of durability monitoring activities expanded to 14 countries (**Benin, Burma, DRC, Ethiopia, Guinea, Kenya, Madagascar, Malawi, Mozambique, Nigeria, Senegal, Tanzania, Uganda,** and **Zimbabwe**), 10 of which have now conducted surveys 12 months after baseline. Additional countries are preparing for implementation in the coming year, such as **Mali, Rwanda,** and **Zambia**.

MONITORING AND RESPONDING TO ANTIMALARIAL DRUG RESISTANCE

The U.S. Agency for International Development (USAID)-supported therapeutic efficacy surveillance (TES) in the **Greater Mekong Subregion** (GMS) identified evidence of artemisinin resistance in 2006. At that time, many patients showed slow clearance of infections after 3 days of treatment with an artemisinin-combination therapy (ACT), which is now recognized as evidence of resistance to artemisinin. Initially, all patients cleared their infection within 7 days. But, in subsequent years, these TES showed a growing number of treatment failures resulting from development of resistance to both artemisinin and the partner drug. These treatment failures, which initially occurred along the Thai-Cambodian border area, are now present in other locations in the GMS, and in some limited areas, there is resistance to up to four artemisinin-partner drug combinations (see Figure 1, previous page).

In 2014, mutations in the K13 gene of the malaria parasite DNA were found to correlate with clinical evidence of artemisinin resistance. Subsequent testing of blood samples from PMI-supported TES sites identified patients infected with K13-mutant malaria parasites in all countries in the GMS, confirming the presence of artemisinin resistance in the subregion.

In FY 2016, PMI supported a network of 41 TES sentinel sites in the GMS to provide up-to-date information on efficacy of first-line antimalarial drugs and potential alternatives, as appropriate. PMI also supports regular regional and in-country reviews of these data to inform updating of national malaria treatment guidelines and sharing of these data among countries in the region.

In FY 2015, based on findings of TES, PMI provided technical assistance to update the malaria treatment policies in **Burma, Cambodia,** and **Thailand** to respond to documented delayed parasite clearance to the existing ACT regimens in parts of those countries. In FY 2016, PMI continued to monitor the situation to inform timely policy changes. In addition to testing for mutations in the K13 gene and markers of mefloquine resistance, PMI is now supporting the testing of recently discovered molecular markers of piperaquine resistance in **Cambodia, Laos,** and **Viet Nam**.

There is currently no evidence of artemisinin resistance outside of the GMS. However, with the multifocal emergence and presence of resistance within the GMS, it is more important than ever to carefully monitor malaria treatment efficacy in sub-Saharan Africa. In addition, TES in Africa has recently demonstrated evidence of resistance to partner drugs, further demonstrating the importance of monitoring therapeutic efficacy on the continent. PMI supports regular TES, carried out every 2 years in accordance with WHO guidelines, to ensure emergence of resistance to ACTs, if it occurs, is promptly detected and responded to so that the efficacy of currently available malaria treatments can be preserved.

During 2016, PMI supported the planning and/or implementation of TES in 13 PMI focus countries in Africa and all countries in the GMS (see Figure 1).[2] PMI has also incorporated monitoring for K13 mutations and other molecular markers of antimalarial resistance. Country staff genotype samples collected in TES sites during training at the CDC laboratory in Atlanta, thus building their expertise in molecular laboratory techniques. In 2016, PMI supported training and capacity building in molecular drug resistance testing for trainees from **Guinea, Malawi, Mali,** and **Tanzania**. PMI has supported monitoring of K13 mutations

2 Those African countries were: Angola, Benin, DRC, Ethiopia, Guinea, Kenya, Madagascar, Mali, Rwanda, Senegal, Tanzania, Uganda, and Zambia. TES was supported by other global malaria partners in Ghana, Malawi, Mozambique, and Nigeria.

Brant Stewart, RTI

in seven African countries[3] to date, none of which have exhibited markers associated with artemisinin resistance.

SURVEILLANCE AND RESPONSE TO FAKE AND SUBSTANDARD MEDICINES

Fake and substandard malaria medicines continue to be a global threat to effective malaria case management, having a negative impact on treatment outcomes and confidence in ACTs. As a major procurer of ACTs, PMI employs a stringent quality assurance and quality control strategy to monitor the quality of drugs procured by PMI. PMI also supports countries to improve local quality assurance and monitoring programs to identify substandard medicines in the public and private sector supply chains. In FY 2016, PMI-supported activities to combat fake and substandard medicines included:

- PMI helped **Guinea** and **Nigeria** to revise their regulations and policies to protect against poor quality medicines. In Guinea, the government passed updated pharmaceutical legislation that included new provisions related to registration and post-market surveillance of medicines. In Nigeria, the National Council on Health approved the National Quality Assurance Policy, which establishes quality assurance and quality control regulations for all medical products along various points of the supply chain.

- In addition, PMI assisted eight focus countries (**Angola, Benin, Guinea, Kenya, Liberia, Malawi, Mali,** and **Nigeria**) to develop systems to assess the quality of medicines and to conduct post-market surveillance of the quality of malaria medicines available for sale in the private health sector in PMI focus countries.

- PMI works with USAID's Office of Inspector General in support of its *Make a Difference (MAD)* communication campaign to mobilize consumers and vendors of medicines to be vigilant in identifying and reporting the distribution of fake or stolen antimalarial medicines. The MAD hotline allows members of the public to report suspected antimalarial theft or counterfeiting that in turn aids local law enforcement to investigate and take legal action. In FY 2016, PMI collaborated with MAD program activities by providing technical assistance in **Malawi** and **Nigeria**.

- In FY 2016, PMI piloted the "Promoting Quality Malaria Medicines through SBCC Implementation Kit." This kit is an online tool to support program managers interested in developing tailored social and behavior change communication (SBCC) strategies to address potential problems related to malaria medicines quality. The implementation kit was refined through a demonstration project in Akwa Ibom State in **Nigeria** and then introduced to international partners at a series of global health conferences as well as a global webinar. In Akwa Ibom, a correlation was demonstrated between exposure to campaign messages and knowledge of techniques to confirm quality of malaria medicines. After the demonstration in Nigeria, surveys found significant changes in public knowledge about the dangers of substandard medicines and how to avoid them, as well as an increased intention among respondents to take steps to protect themselves from substandard ACTs.

3 Those countries are: Angola, Guinea, Kenya, Malawi, Mali, Senegal, and Tanzania.

RTI

6. Building Capacity and Health Systems

The gains achieved to date in malaria control are more likely to be sustained if endemic countries have strong health systems. The U.S. President's Malaria Initiative (PMI) is supporting efforts to strengthen health systems in focus countries, with an emphasis on building capacity of healthcare workers, strengthening pharmaceutical and supply chain management systems, building infrastructure and technical capacity for routine surveillance, monitoring and evaluation, improving laboratory systems (see Chapters 2 and 4), and strengthening management and leadership skills of national malaria control programs (NMCPs).

BUILDING THE CAPACITY OF HEALTH WORKERS

Healthcare workers are at the frontlines of malaria service delivery in communities and health facilities throughout PMI focus countries. A well-trained health workforce is essential to achieving PMI's objectives and goal. It is critical that they be well-versed in their country's policies on malaria prevention and diagnosis and treatment. Building the capacity of healthcare workers at both community and facility levels has, therefore, been a priority for PMI support in all focus countries. During FY 2016, PMI supported training for more than 51,000 health workers in malaria case management and more than 43,000 clinicians and laboratory technicians in procedures for quality diagnostic testing for malaria. Furthermore, PMI supports integrated training of healthcare workers on the implementation of focused antenatal care (ANC) services, including prevention of malaria in pregnancy using insecticide-treated nets (ITNs) and intermittent preventive treatment for pregnant women (IPTp) with sulfadoxine-pyrimethamine (SP). In FY 2016, more than 38,000 healthcare workers were trained in IPTp delivery with PMI support. PMI supports integrated approaches to capacity building, which includes conducting joint trainings for health workers on both malaria in pregnancy and malaria case management and fostering collaboration between national malaria control programs and maternal health programs to improve service delivery. In addition, PMI also supports capacity building for health workers that implement integrated community case management (iCCM) and seasonal malaria chemoprevention (SMC) (see Chapter 2).

Examples of FY 2016 capacity building activities supported by PMI include:

- In **Ethiopia**, correct identification of malaria cases has become more urgent as malaria control efforts have drastically reduced the burden of disease, resulting in a higher proportion of fevers due to causes other than malaria. PMI has been providing long-term support to a mentorship program that focuses on building skills to differentiate and manage common febrile illnesses including malaria, typhoid, typhus, measles, and acute respiratory tract infections. In FY 2016, more than 1,500 clinicians at 384 health facilities received mentoring, for a total of more than 3,900 clinicians from more than 1,200 health facilities and universities since the program began 8 years ago. Before the program started, 18 percent of patients who tested negative for malaria were prescribed antimalarial medicines. Now, this proportion has dropped to just 1 percent. Given the success of this program, Ethiopia plans to continue extending mentorship to additional facilities to build their capacity.

- PMI partners, in collaboration with the **Ghana** Health Service, organized a 5-day training program to build the capacity of 45 Community Health Officers across 9 districts in the Volta Region. Officers received coaching and mentoring on how to assess and manage fevers as well as the need to avoid giving malaria treatment to patients who test negative for malaria. The proportion of suspected malaria cases tested by rapid diagnostic test (RDT) in these districts increased from 47 percent in FY 2015 to nearly 100 percent in FY 2016. Based on these results, the training program is currently being expanded to cover an additional 9 districts and 90 Community Health Officers.

- Following the end of the Ebola outbreak in **Guinea**, the country experienced an increased need for trained health professionals, particularly staff with infection prevention and control skills. To address this need, PMI supported the training of a total of 1,967 health workers at both the fa-

cility and community levels. The trained community health workers conducted a total of 160,612 home visits and were able to reach more than 1.3 million people with key malaria messages.

- In **Madagascar**, an assessment conducted in 2015 found that only about a quarter (27 percent) of the 31 sampled health facilities in 15 PMI-supported regions were offering IPTp in accordance with 2005 World Health Organization (WHO) recommendations. To improve this situation, PMI collaborated with the Directorate of Family Health and the NMCP to train nearly 1,200 community- and facility-level health workers at the national and regional level on the WHO recommendations. Further trainings will be implemented in 2017 to reach an additional 1,500 healthcare providers and thus continue to improve IPTp2 coverage.

- As part of its national strategy for a malaria-free **Nigeria**, the country is seeking to ensure that all pregnant women attending antenatal clinics have access to and use appropriate preventive measures such as IPTp with SP. While national guidelines have been revised to reflect this new WHO recommendation, implementing these guidelines across the different levels of Nigeria's decentralized healthcare system has been challenging. Private and rural health facilities are often left out and not effectively supervised to implement national guidelines. To address these challenges, PMI supported malaria in pregnancy training for private sector health providers in 9 out of 11 focus states. The inclusion of private providers is anticipated to improve the delivery of IPTp in private hospitals and expand IPTp coverage to more women. PMI plans to evaluate the improvements resulting from this effort through mid-term project reviews and the overall outcome via national household surveys.

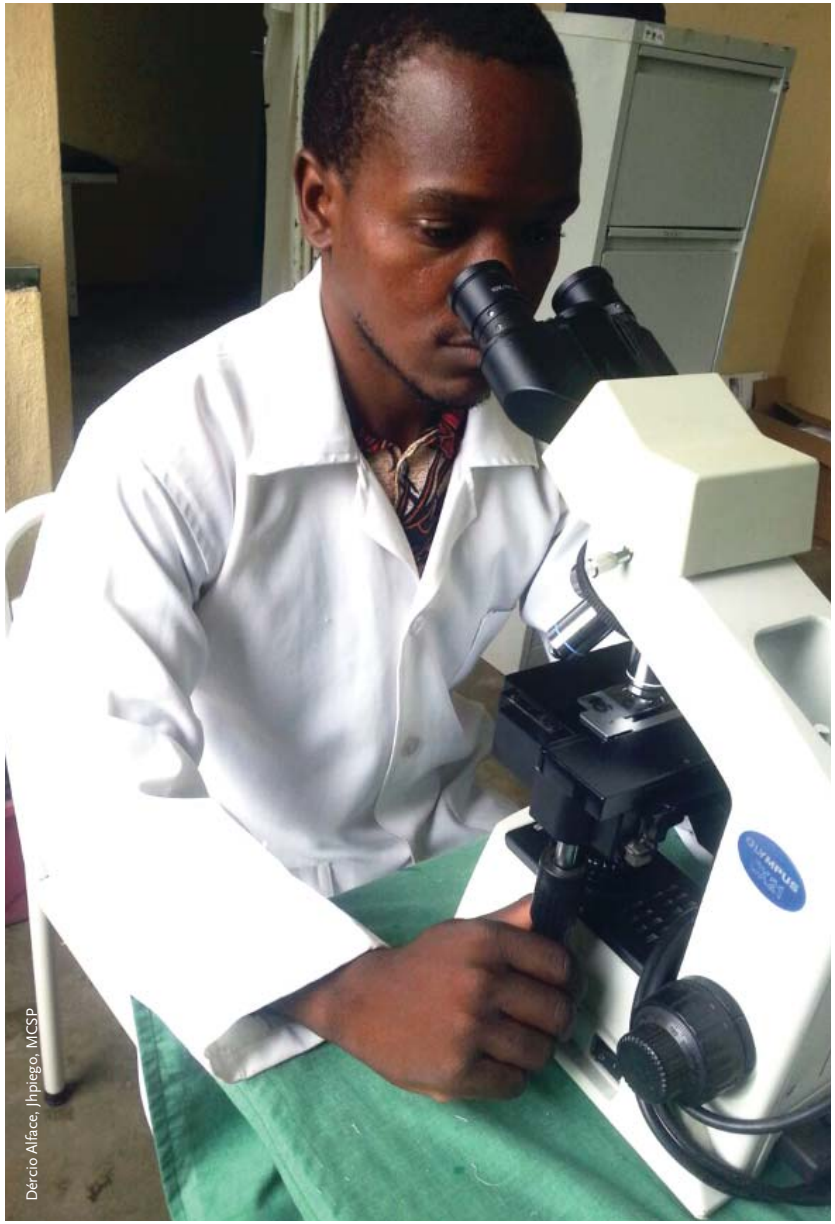
- In **Tanzania**, PMI supported a program that mentored 319 health providers and supervisors in health facilities in four highly malarious regions within the Lake and Southern Zones to improve their skills in the delivery of malaria in pregnancy services. For example, the improvement of services has led to the increase in uptake of IPTp2 in the regions of Kagera (from 36 percent to 69 percent) and Mara (from 27 percent to 54 percent). The program also focuses on the importance of ensuring availability of key commodities such as SP, ACTs, and RDTs, and using data for decision-making. To support health workers, PMI supported the revision of national malaria diagnosis and treatment guidelines and updated laboratory registers, standard operating procedures, and job aids.

Figure 1. Percent of PMI Focus Countries with Malaria Commodity Stocks (ACTs and RDTs) at or above Minimum Inventory Levels at Central Medical Stores, 2011–2016

Note: "Minimum stock on hand" is calculated by accounting for the normal lead time needed to replenish stock as well as unexpected delays and uncertainties. These factors are country specific, thus the minimum stock on hand varies by country. Though data are collected quarterly, some countries are unable to report every quarter due to difficulty obtaining the data or other reasons; the countries included in this graph vary by quarter. PMI continues to work with countries to improve reporting.

STRENGTHENING PHARMACEUTICAL AND SUPPLY CHAIN MANAGEMENT SYSTEMS

While a trained health workforce is critical to success, effective malaria control is equally dependent on the availability of key malaria commodities such as RDTs, ACTs, SP, and ITNs. PMI invests approximately 40 percent of its overall budget on the procurement of these lifesaving products. Ensuring access to these crucial commodities where they are most needed requires a well-functioning supply chain and distribution system. Therefore, in all countries, PMI also provides significant investment to strengthen systems to: 1) select appropriate drugs and other commodities; 2) quantify drug and commodity requirements; 3) ensure quality of drugs and other commodities; 4) develop and implement logistics management information systems; 5) strengthen stock management systems; and 6) build health worker capacity in logistics management.


Dércio Alface, Jhpiego, MCSP

Maximizing Performance in Malaria Laboratory Diagnosis in Zambézia Province, Mozambique

According to data from the 2015 National Health Information System, malaria was responsible for 45 percent of admissions and 28 percent of deaths at health centers in Zambézia. Mozambique's malaria treatment guidelines require all suspected cases of malaria be tested using an RDT or microscopy prior to treatment. Improving the quality of malaria treatment in health facilities depends to a large extent on the skill level of laboratory technicians.

PMI is, therefore, supporting activities with the Zambézia Provincial Health Directorate to improve the ability of laboratory technicians to properly identify and diagnose malaria. In September 2016, PMI supported training for laboratory technicians from 10 districts in Zambézia.

Pre- and post-tests showed that basic knowledge of malaria procedures and diagnostic testing more than doubled as a result of the training. For example, the proportion of participants who correctly identified malaria parasites on a blood test slide rose from 24 percent before the training to 53 percent after the training. Participants also achieved a 25 percent increase in their ability to identify and classify different malaria parasite species. Although technicians' skills have improved, significant gaps in staff knowledge and performance remain. PMI remains committed to continuously strengthening the capacity of laboratory professionals via mentoring and regular supervision visits alongside provincial and district supervisors.

Alberto Luís Paposseco, one of the participants in the training, stated, "[Before the training,] I did not know how to count the parasites in the blood and was not able to identify different stages of the parasite in the blood, which contributed to the poor diagnosis of malaria in the patient. I am very satisfied with what I learned in this training, [and] it will be advantageous for my work. Knowing that malaria kills many people, I feel that I can help save lives by being able to give the correct diagnosis to the patient, so the clinic can prescribe efficient medication, and the patient can start the treatment and be saved."

Spotlight on Partnerships: Peace Corps

During FY 2016, with financial support from PMI, 930 Peace Corps volunteers in 12 PMI focus countries (Benin, Ethiopia, Ghana, Liberia, Madagascar, Malawi, Mozambique, Rwanda, Senegal, Tanzania, Uganda, and Zambia) worked on joint malaria prevention activities with NMCPs, implementing partners, and PMI in-country teams, reaching more than 560,000 beneficiaries. Peace Corps volunteers trained 4,588 health workers in net distribution, home-based care, diagnostics, and reporting. They also trained more than 7,800 community mobilizers to conduct social behavior change communication on malaria prevention and prompt care seeking, and more than 650 teachers on incorporating malaria prevention into their lesson plans. Furthermore, Peace Corps volunteers helped to distribute more than 73,000 ITNs.

Improved country capacity to track commodities has led to better stock management and forecasting, resulting in more reliable stock levels at central warehouses and at health facilities. Between 2011 and 2016, the percent of PMI focus countries with adequate stocks of ACTs and RDTs at the central level increased from 15 percent for ACTs and 10 percent for RDTs to 67 percent for both commodities (see Figure 1, page 54). PMI also serves as a flexible procurement source when other sources of malaria commodities are insufficient or delayed; in FY 2016, PMI filled eight emergency orders.

Examples of PMI-supported activities during FY 2016 included:

- In the **Democratic Republic of the Congo (DRC)**, PMI supported the NMCP to hold the first national quantification workshop for malaria commodities in June 2016 with the participation of all stakeholders. Previously, each donor had worked directly with the NMCP to quantify commodity needs for its intervention areas, resulting in some overlap and gaps. In addition to improving donor coordination around quantifications, the workshop provided the opportunity to revise some of the assumptions used in estimating needs, resulting in more accurate quantification. PMI and the Global Fund to fight AIDS, Tuberculosis and Malaria (Global Fund) also agreed to share stock to address supply shortages across the regions. The agreement is being finalized in a memorandum of understanding.

- PMI continues to support the integration of malaria commodities into **Ethiopia's** Integrated Pharmaceutical Logistics System. As part of the integration, PMI supported the development of a new model to calculate malaria commodity resupply needs that accounts for seasonality – the look-ahead seasonality index. This index accounts for the higher consumption of malaria commodities that occurs during the peak malaria transmission season and adjusts the amounts resupplied to health facilities accordingly. Previously, the system used average historic consumption to estimate resupply requirements, which does not adequately predict future consumption of malaria products during the peak malaria transmission season. Ethiopia developed look-ahead seasonality indices for each distribution hub using 2010–2015 Public Health Emergency Management case data.

- PMI supported the **Ghana** Health Service to complete route and transportation optimization studies for the Northern and Eastern regions to develop optimized routes to support scheduled delivery of malaria supplies from the Regional Medical Stores to health facilities. Optimizing distribution routes can improve supply chain performance and lower cost. According to the study results, current resource constraints and inventory level variability in the Regional Medical Stores present a strong case for private sector participation in the last-mile delivery of health supplies to facilities. Optimized route models with facility groupings to improve the implementation of scheduled deliveries have been shared with the GHS central and regional levels. The Ghana Health Service is working to replicate the analysis in the other regions of the country.

- In **Guinea**, PMI supported training on quantification techniques for the Procurement and Supply Management Technical Working Group members. This training helped the NMCP to carry out a multi-year quantification of antimalarial commodities using both consumption and epidemiological data. The quantification results have been used to mobilize financial resources from donors, including the Global Fund.

- PMI supported the implementation of the electronic logistics management information system

(eLMIS) in **Rwanda**, and provides ongoing data analysis. The goal of the eLMIS is to provide real-time visibility into stock levels and consumption trends for malaria commodities that can be used to make decisions such as replenishing depleted stocks, redistributing stocks when health facilities are overstocked, and planning national quantification and supply planning exercises. On average, 84 percent of health facilities have been updating their consumption in the eLMIS.

STRENGTHENING MANAGEMENT AND LEADERSHIP SKILLS OF NATIONAL MALARIA CONTROL PROGRAMS

Successful country-owned and country-led malaria control programs are only possible when country programs possess appropriately skilled human resources and the necessary infrastructure to plan, implement, and monitor progress of their malaria control activities. Since country ownership is at the core of PMI's strategic and implementation approach, PMI carries out annual planning visits with NMCPs, their partners, and other donors to collaboratively develop annual PMI Malaria Operational Plans that directly support national malaria control strategies and priorities. PMI also provides technical assistance to NMCPs to strengthen the management, organizational, and technical capacity of malaria program staff to effectively implement and oversee malaria activities.

Examples of PMI-supported activities that aim to build and strengthen capacity of NMCP staff during FY 2016 include:

- In **DRC**, PMI has supported capacity building in monitoring and evaluation (M&E) for the NMCP by appointing a full time M&E advisor to the NMCP to provide hands-on technical assistance and coaching. As the NMCP M&E system became more functional and the capacity of the NMCP M&E division has increased, this direct support at the central level gradually evolved into remote technical assistance. PMI has been supporting a similar approach in 5 of 11 NMCP offices at the provincial level, where appointed advisors assist with supervision and assuring routine data quality.

- In **Guinea**, PMI continued to strengthen the NMCP's coordination and management skills through an embedded technical advisor that provided staff mentorship and coaching to strengthen management and oversight of malaria program implementation and provided program coordination support for key activities such as the quarterly Roll Back Malaria Guinea partners meetings.

- In **Liberia**, PMI supported the development of a national malaria social and behavior change communication strategy to complement the malaria strategic plan. PMI supported the NMCP to convene a strategy and writing workshop attended by malaria and social and behavior change communication partners from across the country. During the workshop, participants analyzed available data, selected behavioral and communication objectives, and determined culturally and context appropriate strategies for achieving the selected behavioral and communication objectives. Following the completion of the strategy, PMI supported the NMCP to develop an implementation plan to articulate the role all development and implementing partners will play in achieving the objectives outlined in the strategy, which will improve the NMCP's planning and coordination capacity.

- In **Zimbabwe**, PMI supported the temporary assignment of an experienced entomologist to the NMCP, providing much needed in-house entomological expertise. This support is especially important as the NMCP has prioritized entomological surveillance given the country's five malaria transmission zones and an increasingly heterogeneous malaria transmission pattern. The newly appointed entomologist is assisting with coordinating and managing partners to reach the entomological goals in the country's new malaria strategic plan.

Through support to the U.S. Centers for Disease Control and Prevention's (CDC's) Field Epidemiology and Laboratory Training Program (FELTP), PMI helps build a cadre of ministry of health staff with technical skills in the collection, analysis, and interpretation of data for decision-making, policy formulation, and epidemiologic investigations in 11 PMI focus countries in Africa (**Angola, DRC, Ethiopia, Ghana, Kenya, Mozambique, Nigeria, Rwanda, Tanzania, Uganda,** and **Zambia**) and one PMI program in the **Greater Mekong Subregion** (**Burma**). PMI has supported more than 100 trainees globally to date.

Examples of FELTP trainee-led activities that took place during FY 2016 include:

- To inform ongoing and future malaria programs, PMI-funded FELTP trainees in **Angola** provided technical support alongside PMI country staff for the implementation of a PMI-

funded health facility survey that assessed the provision of malaria case management services in 90 randomly selected public health facilities in 2 provinces from February to March 2016. Findings were disseminated to provincial directorates of health. The survey found shortages of ACT and severe malaria drugs in both provinces and identified a critical need for increasing the number of supportive supervisory visits to improve the quality of case management.

- In **Ghana**, PMI-funded FELTP trainees in collaboration with the PMI country team and the NMCP carried out activities to inform NMCP implementation improvements, including: (1) an evaluation of the malaria surveillance system; (2) an evaluation of the malaria diagnosis and treatment practices in Tolon District, Northern Region; (3) a review of adherence to the WHO-recommended parasite count and species identification method of malaria diagnosis by trained laboratory personnel in the Greater Accra Region; and (4) an analysis of factors associated with IPTp uptake among pregnant women in Denkyembour District.

- In **Nigeria**, PMI-funded FELTP trainees in collaboration with the National Malaria Elimination Program organized a Malaria Research Dissemination Workshop that launched a compendium of abstracts of malaria research done by FELTP fellows over the last 8 years in the country. This activity sought to highlight evidence, strengths, and gaps in malaria implementation and research in Nigeria.

- In **Tanzania**, two PMI-funded FELTP trainees were embedded within the Ministry of Health where they worked daily with the staff of the mainland and Zanzibar malaria control programs. They conducted evaluations of malaria surveillance systems, participated in malaria data quality assessments and dissemination, and participated in school-based malaria surveys, which generated data for both local and national level decision-making.

- A PMI-supported FELTP trainee in **Uganda** worked closely with the PMI team and the NMCP to conduct several critical studies regarding factors associated with increased malaria morbidity in Northern Uganda, as part of efforts to address the malaria upsurge occurring in that area. The trainee's work included leading several district and national level investigations, the results of which were used by PMI and the NMCP to better understand long-lasting ITN use and better target future net-related social and behavior change communication efforts. Another PMI-supported FELTP trainee provided technical assistance to the NMCP in data analysis and entomological monitoring and surveillance.

Spotlight on Partnerships: Global Health Security Agenda

The world is more connected than in any time in human history. Distance no longer affords protection from disease. A number of factors, including weak health systems; poverty; inadequate water, sanitation, and hygiene systems; and fragile surveillance systems, increase the vulnerability of many communities in sub-Saharan Africa to epidemics. In today's tightly connected world, disease can be transported from an isolated, rural village to a major city in as quickly as 36 hours. The Global Health Security Agenda (GHSA) is a joint effort by the U.S. Government, other nations, international organizations, and public and private stakeholders, to accelerate progress toward a world safe and secure from infectious disease threats by preventing, detecting, and rapidly responding to infectious disease outbreaks. The GHSA promotes global health security as a national priority in partner countries through targeted capacity building activities, such as improving laboratory systems, strengthening disease surveillance, improving biosafety and biosecurity, expanding workforce development, and improving emergency management.

PMI works in synergy with the GHSA by contributing to key elements of global health security including countering antimicrobial resistance (see Chapter 5), strengthening national laboratory systems (see Chapter 2), investing in real-time surveillance (see Chapter 4), and workforce development (see Chapter 6). In addition, PMI-supported community level programs provide the first point of care and referral for epidemic diseases as well as a platform for response to public health emergencies. PMI-supported activities directly support the achievement of the overall goals and objectives of the GHSA.

Sarah Hoibak, VectorWorks, Courtesy of Photoshare

APPENDIX 1: PMI FUNDING FY 2006–FY 2016 (IN US$)

Blue Text = Jump-start Funding

	Country[1]	FY 2005 Jump-start Funding	FY 2006	FY 2007[2]	FY 2008[3]	FY 2009	FY 2010[4]	FY 2011[5]	FY 2012[6]	FY 2013[7]	FY 2014[9]	FY 2015[10]	FY 2016[11]	Total
Round 1	Angola	1,740,000	7,500,000	18,500,000	18,846,000	18,700,000	35,500,000	30,614,000	30,750,000	28,547,000	29,000,000	28,000,000	27,000,000	274,697,000
	Tanzania	2,000,000	11,500,000	31,000,000	33,725,000	35,000,000	52,000,000	46,906,000	49,000,000	46,057,000	46,000,000	46,000,000	46,000,000	445,188,000
	Uganda	510,775	9,500,000	21,500,000	21,822,000	21,600,000	35,000,000	34,930,000	33,000,000	33,782,000	34,000,000	34,000,000	34,000,000	313,644,775
Round 2	Malawi		2,045,000	18,500,000	17,854,000	17,700,000	27,000,000	26,447,000	24,600,000	24,075,000	22,000,000	22,000,000	22,000,000	224,221,000
	Mozambique		6,259,000	18,000,000	19,838,000	19,700,000	38,000,000	29,241,000	30,000,000	29,023,000	29,000,000	29,000,000	29,000,000	277,061,000
	Rwanda		1,479,000	20,000,000	16,862,000	16,300,000	18,000,000	18,962,000	18,100,000	18,003,000	17,500,000	18,000,000	18,000,000	181,206,000
	Senegal		2,168,000	16,700,000	15,870,000	15,700,000	27,000,000	24,451,000	24,500,000	24,123,000	24,000,000	24,000,000	24,000,000	222,512,000
Round 3	Benin		1,774,000	3,600,000	13,887,000	13,800,000	21,000,000	18,313,000	18,500,000	16,653,000	16,500,000	16,500,000	16,500,000	157,027,000
	Ethiopia		2,563,000	6,700,000	19,838,000	19,700,000	31,000,000	40,918,000	43,000,000	43,772,000	45,000,000	44,000,000	40,000,000	336,491,000
	Ghana		1,478,000	5,000,000	16,862,000	17,300,000	34,000,000	29,840,000	32,000,000	28,547,000	28,000,000	28,000,000	28,000,000	249,027,000
	Kenya		5,470,000	6,050,000	19,838,000	19,700,000	40,000,000	36,427,000	36,450,000	34,257,000	35,000,000	35,000,000	35,000,000	303,192,000
	Liberia			2,500,000	12,399,000	11,800,000	18,000,000	13,273,000	12,000,000	12,372,000	12,000,000	12,000,000	14,000,000	120,344,000
	Madagascar		2,169,000	5,000,000	16,862,000	16,700,000	33,900,000	28,742,000	27,000,000	26,026,000	26,000,000	26,000,000	26,000,000	234,399,000
	Mali		2,490,000	4,500,000	14,879,000	15,400,000	28,000,000	26,946,000	27,000,000	25,007,000	25,000,000	25,000,000	25,000,000	219,222,000
	Zambia		7,659,000	9,470,000	14,879,000	14,700,000	25,600,000	23,952,000	25,700,000	24,027,000	24,000,000	24,000,000	25,000,000	218,987,000
Round 4	DRC						18,000,000	34,930,000	38,000,000	41,870,000	50,000,000	50,000,000	50,000,000	282,800,000
	Nigeria						18,000,000	43,588,000	60,100,000	73,271,000	75,000,000	75,000,000	75,000,000	419,959,000
	Guinea							9,980,000	10,000,000	12,370,000	12,500,000	12,500,000	15,000,000	72,350,000
	Zimbabwe							11,977,000	14,000,000	15,035,000	15,000,000	15,000,000	15,000,000	86,012,000
	Mekong[8]							11,976,000	14,000,000	3,521,000	3,000,000	3,000,000	3,000,000	38,497,000
	Burma									6,566,000	8,000,000	9,000,000	10,000,000	33,566,000
	Cambodia									3,997,000	4,500,000	4,500,000	6,000,000	18,997,000
	Headquarters		1,500,000	10,000,000	21,596,500	26,100,000	36,000,000	36,000,000	36,000,000	37,500,000	37,500,000	38,000,000	38,000,000	318,196,500
	PMI Total		**30,000,000**	**154,200,000**	**295,857,500**	**299,900,000**	**500,000,000**	**578,413,000**	**603,700,000**	**608,401,000**	**618,500,000**	**618,500,000**	**621,500,000**	**4,928,971,500**
	Jump-Start Total	**4,250,775**	**35,554,000**	**42,820,000**	**0**	**0**	**36,000,000**	**0**	**0**	**0**	**0**	**0**	**0**	**118,624,775**
	Total Overall	**4,250,775**	**65,554,000**	**197,020,000**	**295,857,500**	**299,900,000**	**536,000,000**	**578,413,000**	**603,700,000**	**608,401,000**	**618,500,000**	**618,500,000**	**621,500,000**	**5,047,596,275**

(1) This table does not include other U.S. Government funding for malaria activities from the U.S. Agency for International Development (USAID), the U.S. Centers for Disease Control and Prevention (CDC), the National Institutes of Health or the Department of Defense. (2) $25 million plus-up funds include $22 million allocated to 15 PMI focus countries ($19.2 million for Round 2 countries and $2.8 million for jump-starts in Round 3 countries). (3) Levels after USAID 0.81-percent rescission. (4) In FY 2010, USAID also provided funding for malaria activities in Burkina Faso ($6 million), Burundi ($6 million), Pakistan ($5 million), South Sudan ($4.5 million), the Amazon Malaria Initiative ($5 million), and the Mekong Malaria Programme ($6 million). (5) In FY 2011, USAID also provided funding for malaria activities in Burkina Faso ($5,988,000), Burundi ($5,988,000), South Sudan ($4,491,000), and the Amazon Malaria Initiative ($4,990,000). (6) In FY 2012, USAID also provided funding for malaria activities in Burkina Faso ($9,000,000), Burundi ($8,000,000), South Sudan ($6,300,000), and the Amazon Malaria Initiative ($4,000,000). (7) In FY 2013, USAID also provided funding for malaria activities in Burkina Faso ($9,421,000), Burundi ($9,229,000), South Sudan ($6,947,000), and the Amazon Malaria Initiative ($3,521,000). (8) Starting in FY 2011, PMI funding to the Greater Mekong Subregion was programmed through the Mekong Regional Program. With FY 2013 funding, PMI began supporting activities in Burma and Cambodia directly. In addition, PMI continued to provide FY 2013 funding to the Mekong Regional Program for activities in the region outside of the PMI Burma and PMI Cambodia bilateral programs. (9) In FY 2014, USAID also provided funding for malaria activities in Burkina Faso ($9,500,000), Burundi ($9,500,000), South Sudan ($6,000,000), and the Amazon Malaria Initiative ($3,500,000). (10) In FY 2015, USAID also provided funding for malaria activities in Burkina Faso ($12,000,0000), Burundi ($12,000,000), South Sudan ($6,000,000), and the Amazon Malaria Initiative ($3,500,000). (11) In FY 2016, USAID also provided funding for malaria activities in Burkina Faso ($14,000,0000), Burundi ($9,500,000), South Sudan ($6,000,000), and the Amazon Malaria Initiative ($5,000,000).

APPENDIX 2: PMI CONTRIBUTIONS SUMMARY

The reporting timeframe for this PMI annual report is the 2016 fiscal year (October 1, 2015–September 30, 2016). PMI counts commodities (ITNs, SP tablets, ACT treatments, RDTs) as "procured" once a purchase order or invoice for those commodities has been issued by the procurement service agent during the reporting fiscal year. Depending on the country, commodities are reported as "distributed" once they have reached the central medical stores or once they have transitioned beyond the central medical stores to regional warehouses, health facilities, or other distribution points.

1. INDOOR RESIDUAL SPRAYING

Residents Protected by PMI-supported Indoor Residual Spraying (IRS)[1]

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6[2] (FY 2011)	Year 7[3] (FY 2012)	Year 8 (FY 2013)	Year 9 (FY 2014)	Year 10 (FY 2015)	Year 11 (FY 2016)
Round 1	Angola	590,398	612,776	992,856	485,974	650,782	650,782	689,668	676,090	419,353	57,380	0
	Tanzania	1,018,156	1,279,960	1,569,071	2,087,062	4,861,179	4,502,814	7,107,010	4,429,410	3,020,451	2,397,021	2,138,536
	Uganda	488,502	1,865,956	2,211,388	2,262,578	2,794,839	2,839,173	2,543,983	2,581,839	2,565,899	3,086,789[5]	3,738,129[7]
Round 2	Malawi	_	126,126	106,450	299,744	364,349	364,349	321,919	0	0	0	0
	Mozambique	_	2,593,949	1,457,142	2,263,409	2,945,721	2,945,721	2,825,648	2,716,176	2,181,896	2,327,815	1,631,058
	Rwanda	_	720,764	885,957	1,329,340	1,365,949	1,571,625	1,025,181	990,380	705,048	1,248,678	812,714
	Senegal	_	678,971	645,346	661,814	959,727	887,315	1,095,093	690,029	708,999	514,833	496,728
Round 3	Benin	_	_	521,738	512,491	636,448	426,232	652,777	694,729	789,883	802,597	858,113
	Ethiopia	_	3,890,000	5,921,906	6,484,297	2,064,389	2,920,469	1,506,273	1,629,958	1,647,099	1,665,997	1,688,745
	Ghana	_	_	601,973	708,103	849,620	926,699	941,240	534,060	570,572	553,954	570,871
	Kenya	_	3,459,207	3,061,967	1,435,272	1,892,725	1,832,090	2,435,836	0[4]	0	0	0
	Liberia	_	_	_	163,149	420,532	827,404	876,974	367,930	0	0	0
	Madagascar	_	_	2,561,034	1,274,809	2,895,058	2,895,058	2,585,672	1,781,981	1,588,138	1,766,806	1,257,036
	Mali	_	_	420,580	497,122	440,815	697,512	762,146	850,104	836,568	494,205	788,922
	Zambia	_	3,600,000	4,200,000	6,500,000	4,056,930	4,056,930	4,581,465	2,347,545	1,805,174	1,478,598[6]	1,695,921
Round 4	Nigeria	_	_	_	_	_	_	346,115	346,798	0	0	0
	Zimbabwe	_	_	_	_	_	_	_	1,164,586	1,431,643	334,746	365,425
	Total	**2,097,056**	**18,827,709**	**25,157,408**	**26,965,164**	**27,199,063**	**28,344,173**	**30,297,000**	**21,801,615**	**18,270,723**	**16,729,419**	**16,042,198**

(1) A cumulative count of the number of people protected is not provided because many areas have been sprayed on more than one occasion. (2) Angola, Madagascar, Malawi, Mozambique, and Zambia implemented spray rounds during the first quarter of FY 2011, and these activities are, therefore, also reported in the Year 5 (2010) column. (3) During FY 2012, USAID also provided support for an IRS campaign in Burkina Faso, which protected 115,538 people. (4) In FY 2013, PMI did not carry out IRS activities in Kenya due to a policy change in the type of insecticide approved for IRS, which delayed the procurement of the insecticide and thus the timing of the spray operations. (5) In addition to these IRS activities supported with U.S. Government funds, an additional 823,528 people were protected in FY 2015 in Uganda with a donation from DFID. (6) In addition to these IRS activities supported with U.S. Government funds, an additional 522,226 people were protected in FY 2015 in Zambia with a donation from DFID. (7) In addition to these IRS activities supported with U.S. Government funds, an additional 824,825 people were protected in FY 2016 in Uganda with a donation from DFID.

IRS Spray Personnel Trained with PMI Support[1]

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6[2] (FY 2011)	Year 7[3] (FY 2012)	Year 8 (FY 2013)	Year 9 (FY 2014)	Year 10 (FY 2015)	Year 11 (FY 2016)
Round 1	Angola	350	582	2,104	585	834	834	0	691	671	187	0
	Tanzania	536	734	688	2,806	5,890	4,397	10,756	10,046	7,196	5,859	3,562
	Uganda	450	4,062	4,945	4,412	5,171	1,771	541	3,881	3,660	17,891[5]	8,008[7]
Round 2	Malawi	_	300	309	462	929	929	885	765	1,140	0	0
	Mozambique	_	1,190	1,282	1,343	1,996	1,996	1,121	1,128	1,354	1,354	1,746
	Rwanda	_	655	2,091	2,276	2,088	2,357	1,986	1,925	1,501	2,005	1,833
	Senegal	_	275	706	570	1,024	911	1,097	933	933	893	793
Round 3	Benin	_	_	335	347	459	617	825	804	1,642	1,500	1,372
	Ethiopia	_	_	1,198	3,017	4,049	3,855	2,260	2,684	2,886	2,845	2,749
	Ghana	_	_	468	577	572	636	992	669	750	698	694
	Kenya	_	4,697	1,452	1,719	2,496	2,118	5,921	0[4]	0	0	0
	Liberia	_	_	_	340	480	793	802	292	0	0	0
	Madagascar	_	_	1,673	851	1,612	1,612	4,634	2,894	834	1,759	1,580
	Mali	_	_	413	424	549	816	872	853	911	582	1,216
	Zambia	_	1,300	1,413	1,935	2,396	2,396	929	926	822	1,012[6]	1,287
Round 4	Nigeria	_	_	_	_	_	_	351	381	0	0	0
	Zimbabwe	_	_	_	_	_	_	158	0	0	332	351
	Total	**1,336**	**13,795**	**19,077**	**21,664**	**30,545**	**26,038**	**34,130**	**28,872**	**24,300**	**36,917**	**25,191**

(1) A cumulative count of the number of people trained is not provided because many areas have been sprayed on more than one occasion. Spray personnel are defined as spray operators, supervisors, and ancillary personnel. This definition does not include many people trained to conduct information and community mobilization programs surrounding IRS campaigns. (2) Angola, Madagascar, Malawi, Mozambique, and Zambia implemented spray rounds during the first quarter of FY 2011, and these activities are, therefore, also reported in the Year 5 (2010) column. (3) During FY 2012, USAID also provided support for an IRS campaign in Burkina Faso, which trained 332 people. (4) In FY 2013, PMI did not carry out IRS activities in Kenya due to a policy change in the type of insecticide approved for IRS, which delayed the procurement of the insecticide and thus the timing of the spray operations. (5) In addition to these IRS activities supported with U.S. Government funds, an additional 4,106 people were trained in FY 2015 in Uganda with a donation from DFID. (6) In addition to these IRS activities supported with U.S. Government funds, an additional 448 people were trained in FY 2015 in Zambia with a donation from DFID. (7) In addition to these IRS activities supported with U.S. Government funds, an additional 2,162 people were trained in FY 2016 in Uganda with a donation from DFID.

Houses Sprayed with PMI Support[1]

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6[2] (FY 2011)	Year 7[3] (FY 2012)	Year 8 (FY 2013)	Year 9 (FY 2014)	Year 10 (FY 2015)	Year 11 (FY 2016)
Round 1	Angola	107,373	110,826	189,259	102,731	135,856	135,856	145,264	141,782	98,136	14,649	0
	Tanzania	203,754	247,712	308,058	422,749	889,981	833,269	1,338,953	852,103	573,926	482,144	536,368
	Uganda	103,329	446,117	575,903	567,035	878,875	908,627	823,169	855,698	852,358	824,485[5]	829,335[7]
Round 2	Malawi	_	26,950	24,764	74,772	97,329	97,329	77,647	0	0	0	0
	Mozambique	_	586,568	412,923	571,194	618,290	618,290	660,064	536,558	414,232	445,118	337,433
	Rwanda	_	159,063	189,756	295,174	303,659	358,804	236,610	230,573	173,086	304,199	198,970
	Senegal	_	169,743	153,942	176,279	254,559	240,770	306,916	207,116	204,159	130,170	124,757
Round 3	Benin	_	_	142,814	156,223	166,910	145,247	210,380	228,951	254,072	252,706	269,179
	Ethiopia	_	778,000	1,793,248	1,935,402	646,870	858,657	547,421	635,528	667,236	704,945	715,541
	Ghana	_	_	254,305	284,856	342,876	354,207	355,278	197,655	205,230	205,935	211,283
	Kenya	_	1,171,073	764,050	517,051	503,707	485,043	643,292	0[4]	0	0	0
	Liberia	_	_	_	20,400	48,375	87,325	99,286	42,708	0	0	0
	Madagascar	_	_	422,132	216,060	576,320	576,320	502,697	371,391	343,470	373,027	310,426
	Mali	_	_	107,638	126,922	127,273	202,821	205,066	228,985	228,123	133,527	228,672
	Zambia	_	657,695	762,479	1,189,676	1,102,338	1,102,338	916,293	460,303	432,398	311,204[6]	358,256
Round 4	Nigeria	_	_	_	_	_	_	58,704	62,592	0	0	0
	Zimbabwe	_	_	_	_	_	_	_	501,613	622,299	147,949	162,127
	Total	**414,456**	**4,353,747**	**6,101,271**	**6,656,524**	**6,693,218**	**7,004,903**	**7,127,040**	**5,553,556**	**5,068,725**	**4,330,058**	**4,282,347**

(1) A cumulative count of the number of houses sprayed is not provided because many areas have been sprayed on more than one occasion. (2) Angola, Madagascar, Malawi, Mozambique, and Zambia implemented spray rounds during the first quarter of FY 2011, and these activities are, therefore, also reported in the Year 5 (2010) column. (3) During FY 2012, USAID also provided support for an IRS campaign in Burkina Faso, which sprayed 36,870 houses. (4) In FY 2013, PMI did not carry out IRS activities in Kenya due to a policy change in the type of insecticide approved for IRS, which delayed the procurement of the insecticide and thus the timing of the spray operations. (5) In addition to these IRS activities supported with U.S. Government funds, an additional 301,888 houses were sprayed in FY 2015 in Uganda with a donation from DFID. (6) In addition to these IRS activities supported with U.S. Government funds, an additional 98,340 houses were sprayed in FY 2015 in Zambia with a donation from DFID. (7) In addition to these IRS activities supported with U.S. Government funds, an additional 267,039 houses were sprayed in FY 2016 in Uganda with a donation from DFID.

2. INSECTICIDE-TREATED MOSQUITO NETS

Insecticide-Treated Mosquito Nets (ITNs) Procured and Distributed with PMI Support

ITNs Procured
ITNs Distributed

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[1] (FY 2012)	Year 8[2] (FY 2013)	Year 9[3] (FY 2014)	Year 10[4] (FY 2015)	Year 11[5] (FY 2016)	Cumulative[6]
Round 1	Angola	540,949	294,200	734,198	395,748	1,353,298	1,011,800	727,700	1,265,000	600,000	2,500,000	3,400,000	11,811,093
		540,949	0	339,440	446,348	294,169	630,000	207,000	798,000	894,529	1,015,457	1,739,431	6,905,323
	Tanzania	130,000	0	143,560	1,468,966	623,441	0	697,201	1,245,097	550,000	2,710,920	2,210,754	9,779,939
		130,000	0	113,560	1,498,966	623,441	0	697,201	1,245,097	500,000	494,407	1,488,894	6,791,566
	Uganda	376,444	1,132,532	480,000	765,940	1,009,000	709,000	1,200,000	5,000,000	1,752,577[7]	2,427,720[8]	0	14,144,213
		305,305	683,777	999,894	651,203	294,139	221,325	225,890	956,571	114,930	747,320	658,273	5,855,450
Round 2	Malawi	_	1,039,400	849,578	1,791,506	850,000	1,659,700	1,261,285	521,864	900,000	800,000	607,500	10,280,833
		_	211,995	849,578	851,436	457,822	1,142,938	1,768,951	1,011,915	477,261	527,776	930,826	8,062,228
	Mozambique	_	786,000	720,000	1,450,000	500,000	1,200,000	1,200,000	1,200,000	1,150,000	1,565,000	2,154,700	11,925,700
		_	565,000	842,802	930,000	500,000	1,494,277	1,200,000	1,328,379	1,200,000	1,570,875	1,268,500	10,792,670
	Rwanda	_	0	550,000	912,400	100,000	310,000	1,000,500	0	1,400,000	375,000	1,000,000	5,647,900
		_	0	0	500,000	962,400	0	806,100	604,400	0	1,400,000	375,000	4,647,900
	Senegal	_	200,000	790,000	408,000	1,025,000	2,880,000	500,000	1,362,550	1,218,900	1,003,600	1,465,000	10,853,050
		_	196,872	792,951	380,000	28,000	1,546,617	1,614,563	540,980	561,364	498,286	2,440,192	8,599,825
Round 3	Benin	_	221,000	385,697	875,000	634,000	905,000	510,000	1,420,000	1,420,000	800,000	730,000	7,900,697
		_	215,627	45,840	879,415	315,799	699,300	360,000	429,000	1,420,000	800,000	736,851	5,901,832
	Ethiopia	_	102,145	22,284	1,559,500	1,845,200	1,845,200	2,540,000	5,700,000	4,300,000	3,500,000	0	19,569,129
		_	102,145	22,284	559,500	1,000,000	1,845,200	2,510,746	3,600,000	3,560,624	3,552,000	2,816,630	19,569,129
	Ghana	_	60,023	350,000	955,000	2,304,000	1,994,000	1,600,000	2,600,000	1,340,000	1,160,000	1,600,000	12,489,023
		_	60,023	0	350,000	955,000	2,313,546	1,616,400	1,654,200	2,537,900	1,440,700	1,159,450	11,725,119
	Kenya	_	_	60,000	1,240,000	455,000	2,212,500	1,299,195	1,740,000	1,807,500	5,100,000	2,500,000	16,414,195
		_	_	60,000	550,000	690,000	2,589,180	35,090	1,298,259	1,034,262	2,127,033	3,276,520	11,339,544
	Liberia	_	197,000	0	430,000	830,000	650,000	0	0	250,000	288,850	320,000	2,615,850
		_	0	184,000	430,000	480,000	350,000	300,000	0	0	306,550	100,000	2,150,550
	Madagascar	_	_	351,900	1,875,007	1,715,000	0	2,112,000	2,729,750	3,749,450	3,145,250	654,650	16,333,007
		_	_	351,900	1,005,007	2,579,720	2,217,074	0	2,085,671	77,261	154,895	6,669,911	12,924,365
	Mali	_	369,800	858,060	600,000	2,110,000	3,037,150	600,000	3,076,850	2,000,000	1,350,000	1,400,000	13,861,860
		_	369,800	258,060	600,000	0	2,040,964	1,510,000	800,000	2,169,004	2,584,748	1,400,000	11,732,576
	Zambia	_	808,332	186,550	433,235	1,800,000	1,760,146	833,000	2,728,980	1,090,000[9]	800,000	800,000	9,840,243[10]
		_	550,017	444,865	433,235	400,000	1,760,146	833,000	0	1,448,055	1,090,000	800,000	7,759,318

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[1] (FY 2012)	Year 8[2] (FY 2013)	Year 9[3] (FY 2014)	Year 10[4] (FY 2015)	Year 11[5] (FY 2016)	Cumulative[6]
Round 4	DRC	–	–	–	–	824,100	2,000,000	455,000	3,950,000	2,850,000	3,450,000	0	13,529,100
		–	–	–	–	589,553	314,111	2,113,864	142,306	1,284,770	723,003	5,126,434	10,245,076
	Nigeria	–	–	–	–	614,000	1,000,000	3,315,675	4,200,000	4,000,000	9,732,500	8,700,000	31,562,175
		–	–	–	–	0	614,000	204,635	2,496,730	2,357,149	9,019,215	4,020,487	18,712,216
	Guinea	–	–	–	–	–	–	800,000	779,900	180,000	235,000	1,788,500	3,783,400
		–	–	–	–	–	–	0	0	1,307,722	167,869	1,184,470	2,660,061
	Zimbabwe	–	–	–	–	–	–	457,000	699,500	888,000	339,500	735,000	3,119,000
		–	–	–	–	–	–	457,000	699,500	655,680	92,794	1,103,261	3,008,235
	Mekong	–	–	–	–	–	–	298,573	658,000	176,100	200,000	0	1,332,673
		–	–	–	–	–	–	0	118,059	94,201	207,554	146,230	566,044
	Burma	–	–	–	–	–	–	–	–	100,000	793,500	0	893,500
		–	–	–	–	–	–	–	–	254,560	400,342	433,207	1,088,109[11]
	Cambodia	–	–	–	–	–	–	–	–	130,000	50,000	0	180,000
		–	–	–	–	–	–	–	–	69,542	122,811	45,742	238,095[11]
	Total	**1,047,393**	**5,210,432**	**6,481,827**	**15,160,302**	**18,592,039**	**23,174,496**	**21,407,129**	**40,877,491**	**31,852,527**	**42,326,840**	**30,066,104**	**227,866,580**
		976,254	**2,955,256**	**5,305,174**	**10,065,110**	**10,170,043**	**19,778,678**	**16,460,440**	**19,809,067**	**22,018,814**	**29,043,635**	**37,920,309**	**171,275,231**

(1) During FY 2012, USAID also provided support for ITN activities in Burundi; 530,000 ITNs were procured. (2) During FY 2013, USAID also provided support for ITN activities in Burkina Faso and Burundi; 1,625,000 ITNs were procured (3) During FY 2014, USAID also provided support for ITN activities in Burkina Faso, Burundi, and South Sudan; 901,050 ITNs were procured. (4) During FY 2015, USAID also provided support for ITN activities in Burundi and South Sudan; 1,100,000 ITNs were procured and 1,087,800 were distributed. (5) During FY 2016, USAID also provided support for ITN activities in Burkina Faso, Burundi, and South Sudan; 1,465,000 ITNs were procured and 1,224,150 were distributed.(6) The cumulative column takes into account the 3-month overlap between Year 5 (covering the 2010 calendar year) and Year 6 (covering the 2011 fiscal year). (7) In addition to these ITNs procured with U.S. Government funds, 1,047,378 ITNs were procured in FY 2014 for Uganda with a donation from DFID. (8) In addition to these ITNs procured with U.S. Government funds, 388,400 ITNs were procured in FY 2015 for Uganda with a donation from DFID.(9) Of this total, 600,000 ITNs were procured with PEPFAR funds. (10) In addition to these ITNs procured with U.S. Government funds, PMI procured ITNs for Zambia with a donation from DFID: 1 million ITNs were procured in FY 2011; 271,945 ITNs were procured in FY 2013; and 400,000 ITNs were procured in FY 2014. (11) The number of ITNs distributed exceeds ITNs procured because these distributed ITNs include some which were reported as procured under the Mekong row in previous years.

Insecticide-Treated Nets (ITNs) Procured by other Donors and Distributed with PMI Support

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[1] (FY 2012)	Year 8 (FY 2013)	Year 9 (FY 2014)	Year 10 (FY 2015)	Year 11 (FY 2016)	Cumulative[2]
Round 1	Angola	_	0	109,624	17,089	540,851	0	0	484,577	669,503	0	0	1,821,644
	Tanzania	_	0	350,000	117,400	871,680	615,010	1,077,840	0	108,502	170,359	575,175	3,885,966
	Uganda	_	369,900	0	0	2,431,815	125,017	0	3,503,651	19,959,762	0	1,349,778	27,623,923
Round 2	Malawi	_	_	0	10,700	9,600	20,000	0	0	444,580	1,823,353	0	2,308,233
	Mozambique	_	_	78,000	179,730	0	0	0	0	0	0	0	257,730
	Senegal	_	_	0	1,875,456	621,481	385,427	0	0	0	0	0	2,882,364
Round 3	Ethiopia	_	_	_	475,000	0	0	0	0	0	0	0	475,000
	Ghana	_	_	750,000	0	82,600	0	6,788,328	0	0	0	695,061	8,315,989
	Madagascar	_	_	_	290,636	3,204,647	2,772,824	0	0	0	0	0	3,495,283
	Mali	_	_	_	_	_	_	258,000	800,000	0	800,000	0	1,858,000
	Zambia	_	_	_	_	_	_	_	_	951,945	0	0	951,945
Round 4	DRC	_	_	_	_	3,966,000	0	0	2,700	75,267	0	163,350	4,207,317
	Nigeria	_	_	_	_	0	15,389,478	1,852,604	749,033	1,229,902	3,225,147	0	21,582,055
	Guinea	_	_	_	_	_	_	_	_	951,787	950,409	2,369,083	4,271,279
	Mekong	_	_	_	_	_	_	951,019	348,502	0	0	0	1,299,521
	Cambodia	_	_	_	_	_	_	_	_	_	650	0	650
	Total		**369,900**	**1,287,624**	**2,966,011**	**11,728,674**	**19,307,756**	**10,927,791**	**5,888,463**	**24,391,248**	**6,969,918**	**5,152,447**	**85,236,899**

(1) During FY 2012, USAID also provided support for distribution of 327,000 Global Fund-procured ITNs in South Sudan.
(2) The cumulative column takes into account the 3-month overlap between Year 5 (covering the 2010 calendar year) and Year 6 (covering the 2011 fiscal year).

Sulfadoxine-Pyrimethamine (SP) Treatments Procured and Distributed with PMI Support[1]

SP Treatments Procured
SP Treatments Distributed

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[5] (FY 2012)	Year 8[6,7] (FY 2013)	Year 9[8,9] (FY 2014)	Year 10[11,12] (FY 2015)	Year 11[14,15] (FY 2016)	Cumulative[17]
Round 1	Uganda	_	_	18,333	72,666	39,367	26,666	26,667	0	0	0	0	171,033
		_	_	2,556	45,780	40,063	26,666	0	0	0	0	0	107,270
Round 2	Malawi	_	_	_	_	_	_	_	2,070,333	2,070,333	0	0	4,140,667
		_	_	_	_	_	_	_	0	282,667	1,496,667	290,667	2,070,000
	Mozambique	_	_	_	_	3,645,052[2]	0	2,000,000	577,000	1,125,000	2,732,950	0	10,080,002
		_	_	_	_	0	3,645,052	0	2,000,000	1,702,000	1,366,667	1,366,283	10,080,002
	Rwanda	_	583,333	0	0	0	0	0	0	0	0	0	583,333
		_	583,333	0	0	0	0	0	0	0	0	0	583,333
Round 3	Benin	_	_	766,666	0	0	405,863	227,550	900,000	505,845	2,099,600	333,350	5,238,874
		_	_	0	307,121	150,000	309,546	227,550	227,550	450,200	503,342	769,350	2,844,659
	Ghana	_	_	_	_	25,000	0	0	900,000	900,000	3,000,000	0	4,825,000
		_	_	_	_	0	25,000	0	900,000	900,000	0	553,767	2,378,767
	Kenya	_	_	_	840,000	0	0	0	0	0	0	1,669,667	2,509,667
		_	_	_	840,000	0	0	0	0	0	0	0	840,000
	Liberia	_	_	_	78,666	85,333	85,333	79,667	331,667	0	156,667	477,667	1,209,666
		_	_	_	78,666	0	71,333	7,667	79,667	273,667	156,667	156,667	824,333
	Madagascar	_	_	_	_	_	_	_	_	750,000	0	0	750,000
		_	_	_	_	_	_	_	_	0	368,083	266,850	634,933
	Mali	_	_	1,000,000	0	0	0	531,000	633,333	1,800,000[10]	1,800,000[13]	2,000,000[16]	7,764,333
		_	_	0	1,000,000	0	0	531,000	333,333	518,433	1,579,333	1,657,967	5,620,067
	Zambia	_	_	_	666,666	0	3,083,300[4]	0	0	0	0	0	3,749,966
		_	_	_	0	666,666	3,083,300	0	0	0	0	0	3,749,966
Round 4	DRC	_	_	_	_	2,470,000[3]	1,100,000	300,000	1,000,000	0	5,850,000	0	9,620,000
		_	_	_	_	1,370,000	0	223,683	563,786	508,904	1,194,699	3,440,605	7,301,677
	Nigeria	_	_	_	_	_	_	1,000,000	4,000,000	0	4,000,000	2,000,000	11,000,000
		_	_	_	_	_	_	0	498,200	535,162	3,488,300	1,069,151	5,590,813
	Guinea	_	_	_	_	_	_	108,333	280,000	0	621,000	621,000	1,630,333
		_	_	_	_	_	_	108,057	233,333	25,425	199,333	475,971	1,042,119
	Zimbabwe	_	_	_	_	_	_	220,000	189,267	787,500	927,000	0	2,123,767
			_	_	_	_	_	220,000	189,267	787,500	927,000	0	2,123,767
	Total	_	**583,333**	**1,784,999**	**1,657,998**	**6,264,752**	**4,701,162**	**4,493,217**	**10,881,600**	**7,938,679**	**21,187,217**	**7,101,683**	**65,396,641**
		_	**583,333**	**2,556**	**2,271,567**	**2,226,729**	**7,160,897**	**1,317,957**	**5,025,136**	**5,983,958**	**11,280,091**	**10,047,276**	**45,791,705**

(1) Please note that one treatment consists of three tablets. (2) All treatments were procured with non-malaria U.S. Government funds. (3) Of this total, 1,370,000 treatments were procured with non-malaria U.S. Government funds. (4) In addition to the SP treatments procured with U.S. Government funds, 2,250,000 SP treatments were procured in FY 2011 for Zambia with a donation from DFID. (5) In FY 2012, 826,667 SP treatments were procured for Tanzania with funds from the Royal Embassy of the Kingdom of Netherlands. (6) In FY 2013, 2,308,800 SP tablets and 6,926,454 amodiaquine tablets were procured for Senegal for seasonal malaria chemoprevention for approximately 600,000 children. (7) During FY 2013, USAID also procured 1,376,000 SP treatments for South Sudan. (8) In FY 2014, 1,132,800 SP tablets and 1,098,409 amodiaquine tablets were procured for Senegal for seasonal malaria chemoprevention for approximately 625,000 children. (9) During FY 2014, USAID also procured 1,032,000 SP treatments for South Sudan. (10) In FY 2014, in addition to these SP tablets for IPTp, 900,000 SP tablets and 2,700,000 amodiaquine tablets were procured for Mali for seasonal malaria chemoprevention, protecting approximately 104,750 children. (11) In FY 2015, 3,623,375 SP/AQ co-blisters, 2,430,000 SP tablets, and 7,278,000 AQ tablets were procured for Senegal for seasonal malaria chemoprevention for approximately 625,000 children for the 2015 and 2016 campaigns. (12) During FY 2015, USAID also procured a total of 645,333 SP treatments for Burundi and South Sudan; 899,200 SP treatments were distributed. (13) In FY 2015, in addition to these SP tablets for IPTp, 1,600,000 SP/AQ co-blisters were procured for Mali for seasonal malaria chemoprevention, protecting approximately 296,163 children. (14) In FY 2016, 2,363,650 SP/AQ co-blisters were procured for Senegal for seasonal malaria chemoprevention, protecting approximately 600,000 children. (15) During FY 2016, USAID also provided support for IPTp activities in South Sudan. In South Sudan, 250,000 SP treatments were distributed. (16) In FY 2016, in addition to these SP tablets for IPTp, 7,997,820 SP/AQ co-blisters were procured for Mali for seasonal malaria chemoprevention, protecting approximately 974,660 children. (17) The cumulative column takes into account the 3-month overlap between Year 5 (covering the 2010 calendar year) and Year 6 (covering the 2011 fiscal year).

Health Workers Trained in IPTp Use with PMI Support[1]

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[3] (FY 2012)	Year 8 (FY 2013)	Year 9[4] (FY 2014)	Year 10[5] (FY 2015)	Year 11[6] (FY 2016)
Round 1	Angola	1,450	290	1,481	2,554	2,695	1,488	1,308	686	729	646	1,689
	Tanzania	376	1,158	2,532	2,288	2,157	4,634	1,210	162	2,973	403	319
	Uganda	168	807	649	724	870	5,341	5,651	874	579	946	993
Round 2	Malawi	_	_	2,747	348	181	0	31	134	1,100	6,604	956
	Mozambique	_	_	_	_	_	_	776	569	158	0	113
	Rwanda[2]	_	250	436	0	964	225	0	0	0	0	0
	Senegal	_	43	2,422	865	1,025	1,563	672	512	3,842	309	193
Round 3	Benin	_	605	1,267	146	80	0	0	805	1,970	185	282
	Ghana	_	_	464	1,170	2,797	7,577	2,665	1,087	4,201	1,676	13,779
	Kenya	_	_	0	5,107	93	1,844	4,950	5,523	4,310	5,895	9,491
	Liberia	_	_	417	750	535	404	289	289	95	225	0
	Madagascar	_	_	0	0	1,576	3,370	3,808	0	0	0	1,166
	Mali	_	_	142	0	1,173	1,983	270	351	471	142	1,147
	Zambia	_	_	_	63	0	0	387	350	504	0	114
Round 4	DRC	_	_	_	_	0	443	1,347	3,265	2,210	2,485	4,739
	Nigeria	_	_	_	_	0	0	3,456	1,466	1,630	3,098	1,641
	Guinea	_	_	_	_	_	_	313	0	1,052	353	653
	Zimbabwe	_	_	_	_	_	_	215	86	1,382	8,803	1,322
	Total	**1,994**	**3,153**	**12,557**	**14,015**	**14,146**	**28,872**	**27,348**	**16,159**	**27,206**	**31,770**	**38,597**

(1) A cumulative count of individual health workers trained is not provided because some health workers have been trained on more than one occasion. (2) Health workers in Rwanda have been trained in focused antenatal care because IPTp is not national policy. (3) During FY 2012, USAID also provided support for malaria in pregnancy activities in Burkina Faso and South Sudan; 2,077 health workers were trained in IPTp. (4) During FY 2014, USAID also provided support for malaria in pregnancy activities in Burkina Faso and South Sudan; 992 health workers were trained in IPTp. (5) During FY 2015, USAID also provided support for malaria in pregnancy activities in Burkina Faso, Burundi and South Sudan; 1,125 health workers were trained in IPTp. (6) During FY 2016, USAID also provided support for malaria in pregnancy activities in Burkina Faso, Burundi and South Sudan; 1,872 health workers were trained in IPTp.

4. CASE MANAGEMENT

Health Workers Trained in Malaria Diagnosis with PMI Support[1]

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[2] (FY 2012)	Year 8 (FY 2013)	Year 9[3] (FY 2014)	Year 10[4] (FY 2015)	Year 11[5] (FY 2016)
Round 1	Angola	_	374	1,356	691	1,022	1,028	225	487	1,092	1,235	1,247
	Tanzania	_	_	_	247	388	338	83	159	1,256	3,375	3,471
	Uganda	_	_	100	1,115	941	1,651	427	1,281	893	8,917	1,077
Round 2	Malawi	_	_	_	_	307	549	1,039	579	1,063	6,664	348
	Mozambique	_	391	0	136	0	0	0	8	0	44	956
	Rwanda	_	_	_	0	29	0	172	556	5,898	0	0
	Senegal	_	_	90	19	4,158	2,920	1,239	2,212	835	1,555	1,853
Round 3	Benin	_	605	0	24	583	232	884	967	2,546	1,034	209
	Ethiopia	_	_	_	_	_	7,666	9,068	563	738	789	1,428
	Ghana	_	_	_	46	4,511	8,680	2,540	1,292	19,864	4,655	15,088
	Kenya	_	_	77	0	485	210	408	3,257	346	110	709
	Liberia	_	_	_	22	906	39	0	0	0	0	0
	Madagascar	_	_	_	108	2,701	8,932	535	4,620	9,194	7,246	4,142
	Mali	_	_	40	412	1,276	1,957	1,292	375	765	138	1,480
	Zambia	_	_	_	36	0	37	2,017	719	524	82	352
Round 4	DRC	_	_	_	_	28	499	1,762	5,157	4,121	4,383	5,271
	Nigeria	_	_	_	_	_	2	3,555	1,919	1,629	2,262	1,713
	Guinea	_	_	_	_	_	_	835	20	1,821	459	1,658
	Zimbabwe	_	_	_	_	_	_	2,066	86	2,984	8,803	1,322
	Mekong	_	_	_	_	_	_	63	1,975	103	114	109
	Burma	_	_	_	_	_	_	_	_	1,887	1,297	876
	Cambodia	_	_	_	_	_	_	_	_	865	988	64
	Total	**_**	**1,370**	**1,663**	**2,856**	**17,335**	**34,740**	**28,210**	**26,232**	**58,424**	**54,150**	**43,373**

(1) A cumulative count of individual health workers trained is not provided because some health workers have been trained on more than one occasion. (2) During FY 2012, USAID also provided support for case management activities in Burkina Faso and Burundi; 1,789 health workers were trained in malaria diagnostics.(3) During FY 2014, USAID also provided support for case management activities in Burkina Faso and South Sudan; 760 health workers were trained in malaria diagnostics.(4) During FY 2015, USAID also provided support for case management activities in Burkina Faso, Burundi and South Sudan; 1,114 health workers were trained in malaria diagnostics. (5) During FY 2016, USAID also provided support for case management activities in Burkina Faso and Burundi; 1,325 health workers were trained in malaria diagnostics.

Rapid Diagnostic Tests Procured and Distributed with PMI Support

RDTs Procured
RDTs Distributed

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[1] (FY 2012)	Year 8[2] (FY 2013)	Year 9[3] (FY 2014)	Year 10[4] (FY 2015)	Year 11[13] (FY 2016)	Cumulative[5]
Round 1	Angola	129,875	375,000	375,000	600,000	832,000	1,637,000	862,150	2,930,000	2,800,000	0	4,550,000	14,641,025
		0	101,000	380,875	975,000	282,000	1,637,500	1,762,150	900,000	2,030,000	0	3,125,000	11,193,525
	Tanzania	875,000	550,200	1,075,000	950,000	292,000	117,000	212,500[6]	364,500	6,623,800	6,421,325	1,949,100	19,430,425
		250,000	1,025,200	425,000	989,500	661,900	194,574	212,500	202,000	3,254,475	8,071,475	1,949,100	17,171,224
	Uganda	–	–	–	–	1,309,000	1,346,650	2,061,000	525,000	0	1,195,850	2,058,475	7,170,975
		–	–	–	–	34,000	296,985	0	500,000	0	0	1,807,925	2,602,980
Round 2	Malawi	–	–	–	–	–	–	2,966,675	9,227,000	4,000,000	11,700,000	0	27,893,675
		–	–	–	–	–	–	2,966,675	5,227,825	4,476,150	8,552,450	3,154,150	24,377,250
	Mozambique	–	–	–	–	–	5,000,000	1,000,000	9,956,375	14,450,000	6,000,000	8,000,000	44,406,375
		–	–	–	–	–	3,452,550	1,000,000	9,956,375	8,700,000	11,449,405	8,421,991	42,980,321
	Rwanda	–	–	–	–	200,010	200,010	500,010	500,010	1,162,020	0	0	2,362,050
		–	–	–	–	0	109,991	349,219[7]	240,000	500,010	489,810	672,190	2,361,220
	Senegal	–	–	–	–	–	–	700,000	300,000	0	2,555,750	3,200,000	6,755,750
		–	–	–	–	–	–	700,000[8]	300,000	0	1,890,500	520,845	3,411,345
Round 3	Benin	–	178,400	0	0	600,000	600,000	980,000	1,000,000	1,500,000	1,700,000	2,000,000	7,958,400
		–	73,815	104,585	0	0	600,000	490,000	1,190,000	961,825	826,875	980,650	5,227,750
	Ethiopia	–	–	–	1,680,000	1,560,000	0	0	0	0	0	3,000,000	6,240,000
		–	–	–	820,000	2,420,000	0	0	0	0	0	3,000,000	6,240,000
	Ghana	–	–	–	74,000	725,600	725,600	3,048,000	0	5,700,000	1,160,000	10,200,000	20,907,600
		–	–	–		0	725,600	1,000,000	0[9]	3,000,000	1,160,000	6,358,375	12,243,975
	Kenya	–	–	–	–	547,800	547,800	1,745,120	6,547,680	100,000	3,400,000	11,300,000	23,640,600
		–	–	–	–	0	292,040	667,960	3,298,320	4,500,000	500,000	6,135,950	15,394,270
	Liberia	–	–	–	850,000	1,200,000	0	1,900,000	2,500,000	0	1,750,000	2,257,000	10,457,000
		–	–	–	850,000	1,116,275	83,725	0	1,506,450	1,846,525	1,103,575	1,085,000	7,591,550
	Madagascar	–	–	–	–	270,000	1,500,000	778,000	1,000,000	2,780,000	2,000,000	1,900,000	10,228,000
		–	–	–	–	202,031	248,329	1,491,589	0	2,780,000	2,998,380	1,925,925	9,536,774
	Mali	–	–	–	30,000	500,000	500,000	1,000,000	3,000,000	2,000,000	2,000,000	3,000,000	12,030,000
		–	–	–	0	530,000	500,000	600,000	1,253,800	3,832,475	1,753,840	3,559,885	12,030,000
	Zambia	–	979,000	1,639,000	2,070,000	4,804,500	2,337,450	3,056,250	3,530,000	4,000,000	2,172,500	0	22,334,600[10]
		–	0	979,000	1,250,000	2,550,400	2,337,450	999,975	5,586,250	4,000,000	2,172,500	627,233	18,248,708

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[1] (FY 2012)	Year 8[2] (FY 2013)	Year 9[3] (FY 2014)	Year 10[4] (FY 2015)	Year 11[13] (FY 2016)	Cumulative[5]
Round 4	DRC	–	–	–	–	500,000	0	3,500,000	4,000,000	8,000,000	2,875,000	15,000,000	33,875,000
		–	–	–	–	0	400,425	428,175	1,710,676	1,739,736	5,874,078	8,256,889	18,409,979
	Nigeria	–	–	–	–	–	–	2,700,000	4,000,000	2,500,000	6,718,000	5,000,000	20,918,000
		–	–	–	–	–	–	428,400	1,084,425	2,870,612	6,747,289	9,381,075	20,511,801
	Guinea	–	–	–	–	–	–	100,000	1,000,000	1,520,000	0	2,865,000	5,485,000
		–	–	–	–	–	–	100,000	1,000,000	1,520,000	0[12]	1,124,135	3,744,135
	Zimbabwe	–	–	–	–	–	–	1,599,700	1,135,375	2,266,000	2,338,000	836,000	8,175,075
		–	–	–	–	–	–	1,599,700	1,135,375	2,266,000	2,338,000	836,000	8,175,075
	Mekong	–	–	–	–	–	61,000	248,500	424,000	378,700	0	0	1,112,200
		–	–	–	–	–	61,000	5,250	120,126	152,075	160,200	0	498,651
	Burma	–	–	–	–	–	–	–	–	50,000	291,800	240,000	581,800
		–	–	–	–	–	–	–	–	232,100	264,775	105,900	602,775[11]
	Cambodia	–	–	–	–	–	–	–	–	0	285,500	0	285,500
		–	–	–	–	–	–	–	–	10,850	285,500	7,500	303,850[11]
	Total	**1,004,875**	**2,082,600**	**3,089,000**	**6,254,000**	**13,340,910**	**14,572,510**	**28,957,905**	**51,939,940**	**59,830,520**	**54,563,725**	**77,355,575**	**306,889,050**
		250,000	**1,200,015**	**1,889,460**	**4,884,500**	**7,796,606**	**10,940,169**	**14,801,593**	**35,211,622**	**48,672,833**	**56,638,652**	**63,035,718**	**242,857,158**

(1) During FY 2012, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 1,600,000 RDTs were procured and 900,000 were distributed.(2) During FY 2013, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 7,741,300 RDTs were procured and 3,000,000 were distributed.(3) During FY 2014, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 9,941,300 RDTs were procured and 3,000,000 were distributed. (4) During FY 2015, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 7,835,000 RDTs were procured and 8,822,600 were distributed. (5) The cumulative column takes into account the 3-month overlap between Year 5 (covering the 2010 calendar year) and Year 6 (covering the 2011 fiscal year). (6) During FY 2012, an additional 259,200 RDTs were distributed in Tanzania. These RDTs were originally procured for Rwanda and transferred to Tanzania to avoid expiry. (7) Of the 500,010 RDTs Rwanda procured in FY 2012, 259,200 were relocated to Tanzania to avoid expiry. These RDTs are included in this total but were distributed in Tanzania. (8) In FY 2012, an additional 250,000 RDTs procured by other donors were distributed with U.S. Government support in Senegal. (9) In FY 2013, 2,800,000 RDTs procured by the Global Fund were distributed with U.S. Government support in Ghana. (10) In addition to these RDTs procured with U.S. Government funds, PMI procured the following quantities of RDTs for Zambia with a donation from DFID:1,350,000 RDTs in FY 2011, 2,000,000 RDTs in FY 2013, 9,500,000 RDTs in FY 2014, 2,000,000 RDTs in FY 2015, and 450,000 RDTs in FY 2016. (11) The number of RDTs distributed exceeds RDTs procured because these distributed RDTs include some that were reported as procured under the Mekong row in previous years. (12) During FY 2015 558,525 RDTs procured by Global Fund were distributed using U.S. Government funds to PMI zones in Guinea that had a need. (13) During FY 2016, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 5,760,300 RDTs were procured and 4,221,538 were distributed.

Artemisinin-based Combination Treatments (ACTs) Procured and Distributed with PMI Support

ACTs Procured
ACTs Distributed

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[1,2] (FY 2012)	Year 8[3] (FY 2013)	Year 9[4] (FY 2014)	Year 10[5] (FY 2015)	Year 11[10] (FY 2016)	Cumulative[6]
Round 1	Angola	587,520	2,033,200	3,035,520	5,572,860	3,767,040	3,770,010	7,429,800	1,539,000	720,390	1,185,360	2,969,910	28,840,600
		0	1,689,321	3,109,089	1,947,188	3,567,360	3,770,010	3,600,000	3,829,800	1,539,000	1,185,360	2,969,910	27,207,038
	Tanzania	380,160	694,050	146,730	4,001,760	8,751,150	7,608,900	8,201,910	6,278,820	1,674,840	2,644,560	1,229,550	38,040,870
		380,160	494,050	346,730	544,017	4,873,207	8,819,640	8,663,280	1,593,300	7,668,300	3,134,280	1,229,550	35,439,124
	Uganda	261,870	0	1,140,480	0	2,085,120	2,085,120	1,169,820	799,800	762,150	1,326,840	2,793,030	10,339,110
		227,827	0	0	1,140,480	0	545,310	52,501	1,054,490	43,140	1,616,130	3,058,800	7,738,678
Round 2	Malawi	_	4,695,450	8,449,920	1,169,280	1,634,520	214,500	7,691,970	6,520,260	2,378,520	6,201,000	6,378,960	45,119,880
		_	4,694,013	3,579,278	3,693,510	2,198,460	215,100	6,536,307	3,908,910	7,026,480	6,380,730	2,787,740	40,805,428
	Mozambique	_	218,880	4,988,160	0	5,331,840	7,064,040	8,731,950	7,469,790	9,138,480	2,343,150	3,475,080	45,956,250
		_	218,880	1,440,000	2,210,320	1,553,430	4,920,990	5,947,290	8,227,470	8,354,970	7,893,410	3,642,044	43,430,384
	Rwanda	_	714,240	0	0	0	0	0	300,150	1,356,330	2,041,710	622,170	5,034,600
		_	0	714,240	0	0	0	0	300,150	269,430	1,876,001	622,170	3,781,991
	Senegal	_	_	_	443,520	670,080	659,790	355,000	346,110	789,600	220,800	708,650	4,135,470
		_	_	_	0	443,520	455,756	468,776	210,378	486,621	529,672	277,454	2,872,177
Round 3	Benin	_	_	1,073,490	215,040	1,002,240	509,100	1,841,190	132,000	2,032,170	750,660	1,687,470	9,243,360
		_	_	326,544	812,232	1,002,600	470,749	1,181,091	396,716	1,147,590	918,513	996,065	7,245,054
	Ethiopia	_	_	600,000	1,081,000	2,268,000	0	1,787,630	3,610,000	3,000,000	0	0	12,346,630
		_	_	0	1,681,000	648,000	1,596,630	0	1,821,000	3,600,000	1,800,000	1,200,000	12,346,630
	Ghana	_	_	1,142,759	0	0	0	2,090,130	849,460	3,698,170	7,438,930	248,340	15,467,789
		_	_	0	1,028,000	114,759	0	2,090,130	849,460	3,729,850	1,700,625	3,802,815	13,315,639
	Kenya	_	_	1,281,720	7,804,800	6,997,080	6,960,390	9,578,970	4,168,414	13,743,240	2,880,000	4,662,450	55,446,664
		_	_	1,281,720	6,015,360	7,667,310	3,268,260	2,410,810	10,422,328	6,084,137	10,350,990	4,197,750	51,231,185
	Liberia	_	496,000	0	1,303,175	1,631,625	4,444,875	2,375,525	2,703,000	1,451,100	2,484,625	2,597,825	18,916,150
		_	0	496,000	1,303,175	1,631,625	1,623,781	2,375,525	1,865,775	1,066,150	1,632,288	1,066,000	13,060,319
	Madagascar	_	_	_	_	_	100,025	400,000	0	881,000	1,609,900	0	2,990,925
		_	_	_	_	_	0	84,948	387,035	802,154	673,544	942,516	2,890,197
	Mali	_	_	_	241,720	739,200	1,289,190	2,400,030	2,289,720	1,506,300	2,200,410	3,800,070	13,727,440
		_	_	_	241,720	0	1,289,190	900,000	2,274,682	2,923,072	1,088,157	3,800,070	12,516,891
	Zambia	_	_	495,360	0	2,390,400	1,688,160	2,721,060	3,379,830	7,054,620	1,850,640	31,080	18,974,190[7]
		_	_	80,640	173,160	2,257,920	1,688,160	2,721,060	3,080,970	6,799,260	1,850,640	606,895	18,621,745

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[1,2] (FY 2012)	Year 8[3] (FY 2013)	Year 9[4] (FY 2014)	Year 10[5] (FY 2015)	Year 11[10] (FY 2016)	Cumulative[6]
Round 4	DRC	–	–	–	–	3,780,000	0	7,000,000	2,378,400	9,537,400	0	7,504,600	30,200,400
		–	–	–	–	639,075	855,948	1,007,387	4,344,124	4,041,801	9,459,625	9,921,798	30,173,619
	Nigeria	–	–	–	–	0	0	7,201,535	3,584,060	17,955,180	19,304,880	4,346,075	52,391,730
		–	–	–	–	1,043,352[8]	0	1,241,363	3,184,730	7,357,739	17,153,639	15,423,196	45,404,019
	Guinea	–	–	–	–	–	1,450,000	754,750	1,401,300	1,201,580	2,976,375	1,299,825	9,083,830
		–	–	–	–	–	0	915,500	754,725	1,461,581	613,363	1,397,955	5,143,124
	Zimbabwe	–	–	–	–	–	744,120	969,150	581,460	2,251,940	0	0	4,546,670
		–	–	–	–	–	520,884	1,192,386	581,460	2,251,940	0	0	4,546,670
	Mekong	–	–	–	–	–	–	68,070	102,060	64,060	58,140	9,985	302,315
		–	–	–	–	–	–	0	17,415	0	27,463	0	44,878
	Burma	–	–	–	–	–	–	–	–	24,540	11,130	13,200	48,870
		–	–	–	–	–	–	–	–	25,040	15,660	10,743	51,443[9]
	Cambodia	–	–	–	–	–	–	–	–	0	140,190	0	140,190
		–	–	–	–	–	–	–	–	0	0	0	0
	Total	**1,229,550**	**8,851,820**	**22,354,139**	**21,833,155**	**41,048,295**	**38,588,220**	**72,768,490**	**48,433,634**	**81,221,610**	**57,669,300**	**44,378,270**	**421,293,933**
		607,987	**7,096,264**	**11,374,241**	**20,790,162**	**27,640,618**	**30,040,408**	**41,388,354**	**49,104,918**	**66,678,255**	**69,900,090**	**57,953,471**	**377,866,233**

(1) During FY 2012, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 4,991,250 ACTs were procured and 2,367,675 were distributed. (2) During FY 2012, PMI also procured 786,305 ACT treatments for emergency stockpile purposes. These will be counted in next year's annual report once they have been allocated to specific countries. (3) During FY 2013, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 4,289,850 ACTs were procured and 1,830,475 were distributed. (4) During FY 2014, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 10,807,900 ACTs were procured and 5,648,425 were distributed. (5) During FY 2015, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 5,900,700 ACTs were procured and 9,571,725 were distributed. (6) The cumulative column takes into account the 3-month overlap between Year 5 (covering the 2010 calendar year) and Year 6 (covering the 2011 fiscal year). (7) In addition to these ACTs procured with U.S. Government funds, PMI procured the following quantities of ACTs for Zambia with a donation from DFID: 1,599,360 ACTs in 2010, 3,805,560 ACTs in FY 2011, 4,686,750 ACTs in FY 2012, 4,432,140 ACTs in FY 2013, 1,000,200 ACTs in FY 2014, and 2,972,100 ACTs in FY 2016. (8) These ACTs were distributed in 2010 with U.S. Government funds but were procured before Nigeria became a PMI focus country. (9) The number of ACTs distributed exceeds ACTs procured because these distributed ACTs include some which were reported as procured under the Mekong row in previous years. (10) During FY 2016, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 8,655,325 ACTs were procured and 9,521,238 were distributed.

ACTs Procured by other Donors and Distributed with PMI Support

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7 (FY 2012)	Year 8 (FY 2013)	Year 9 (FY 2014)	Year 10 (FY 2015)	Year 11 (FY 2016)	Cumulative[1]
Round 1	Uganda	_	8,709,140	112,330	4,459,918	0	0	0	0	0	0	0	13,281,388
Round 2	Malawi	_	_	_	2,056,170	0	5,015,490	0	0	0	0	0	6,779,580
	Mozambique	_	_	_	1,423,350	2,857,590	1,428,630	0	0	0	0	931,044	5,882,114
	Rwanda	_	_	_	396,625	282,494	114,471	966	0	0	0	0	794,556
	Senegal	_	_	_	_	_	_	275,000	0	0	0	0	275,000
Round 3	Madagascar	_	_	_	519,338	396,470	124,118	674,273	0	0	0	0	1,699,579
	Mali	_	_	_	_	_	_	_	184,319	0	0	0	184,319
Round 4	Nigeria	_	_	_	_	_	311,100	0	0	3,918,793	1,258,947	1,230,316	6,719,156
	Guinea	_	_	_	_	_	_	_	938,480	0	0	0	938,480
	Zimbabwe	_	_	_	_	_	_	_	344,160	0	0	843,651	1,187,811
	Total		**8,709,140**	**112,330**	**8,855,401**	**3,536,554**	**6,993,809**	**950,239**	**1,466,959**	**3,918,793**	**1,258,947**	**3,005,011**	**37,741,983**

(1) The cumulative column takes into account the 3-month overlap between Year 5 (covering the 2010 calendar year) and Year 6 (covering the 2011 fiscal year).

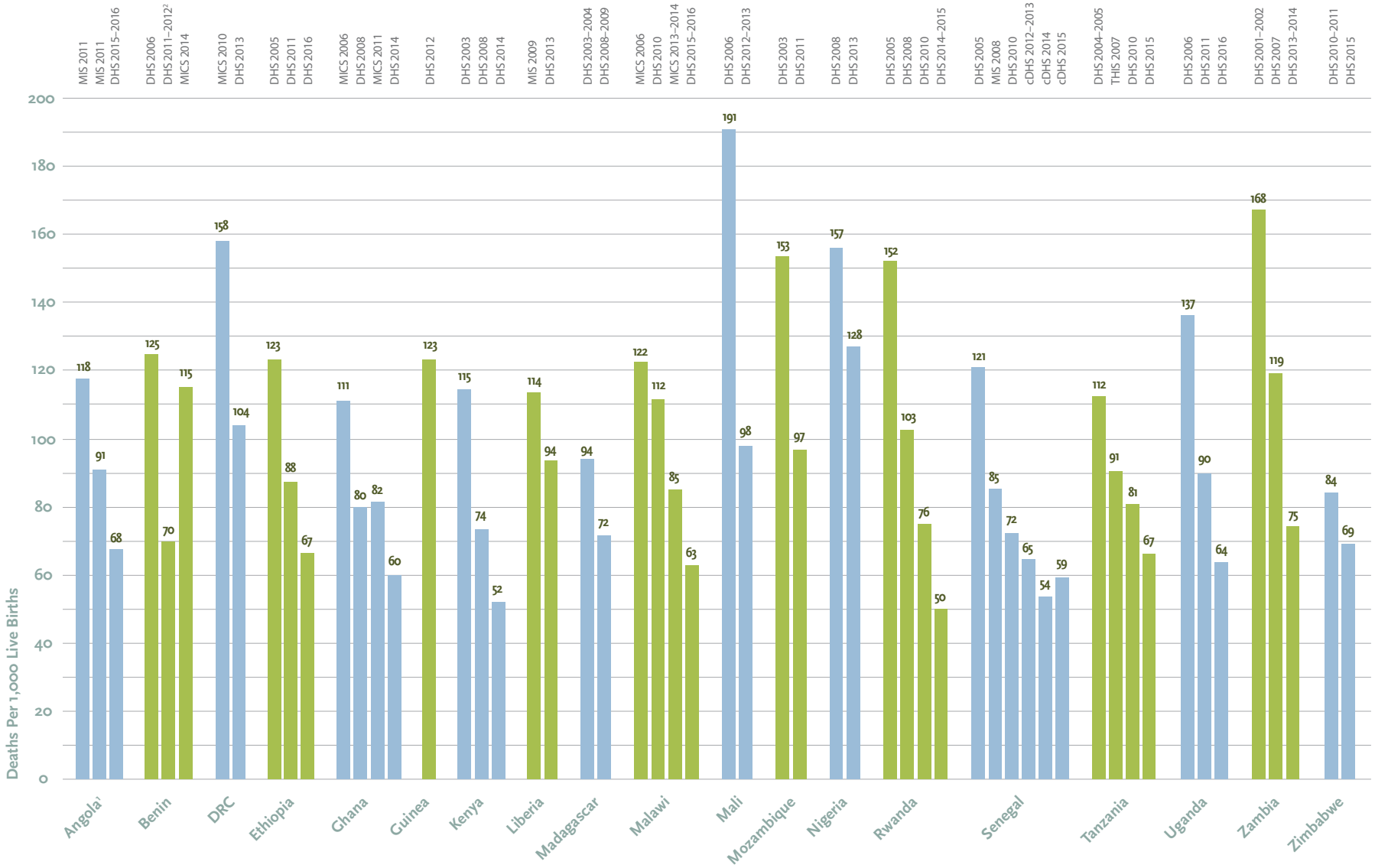
Health Workers Trained in ACT Use with PMI Support[1]

	Country	Year 1 (2006)	Year 2 (2007)	Year 3 (2008)	Year 4 (2009)	Year 5 (2010)	Year 6 (FY 2011)	Year 7[2] (FY 2012)	Year 8 (FY 2013)	Year 9[3] (FY 2014)	Year 10[4] (FY 2015)	Year 11[5] (FY 2016)
Round 1	Angola	1,283	290	1,357	2,784	2,868	238	1,489	2,492	3,164	3,299	2,868
	Tanzania	4,217	1,011	1,767	1,018	1,162	1,520	2,218	162	3,493	2,080	264
	Uganda	2,844	12,637	9,159	1,356	0	485	5,651	767	2,047	8,857	1,077
Round 2	Malawi	_	_	5,315	809	1,813	378	204	540	1,124	6,604	268
	Mozambique	_	174	422	16,768	219	0	2,383	1,190	0	32	253
	Rwanda	_	5,127	8,565	7,672	7,180	8,911	3,098	1,707	5,898	5,314	2,488
	Senegal	_	1,020	4,776	1,162	4,158	2,375	1,196	2,124	4,098	1,474	2,567
Round 3	Benin	_	605	0	762	1,178	1,207	678	907	2,610	1,641	291
	Ethiopia	_	_	2,786	0	1,740	7,666	8,694	4,560	6,570	3,179	725
	Ghana	_	_	368	1,144	2,952	7,954	1,318	10,278	19,619	13,151	12,281
	Kenya	_	_	_	4,747	390	0	0	0	0	0	0
	Liberia	_	_	595	746	1,008	498	289	60	97	220	0
	Madagascar	_	_	_	1,696	4,575	8,039	580	4,582	9,194	7,139	4,112
	Mali	_	_	101	412	1,283	1,957	1,260	328	765	138	5,876
	Zambia	_	_	186	197	0	493	542	655	503	80	255
Round 4	DRC	_	_	_	_	874	462	1,525	5,097	3,811	3,884	5,051
	Nigeria	_	_	_	_	5,058	0	5,608	24,195	14,923	6,866	8,176
	Guinea	_	_	_	_	_	_	707	20	1,675	2,064	1,967
	Zimbabwe	_	_	_	_	_	_	2,066	86	2,984	8,803	1,322
	Mekong	_	_	_	_	_	_	291	1,804	103	70	864
	Burma	_	_	_	_	_	_	_	_	1,790	1,254	876
	Cambodia	_	_	_	_	_	_	_	_	808	939	46
	Total	**8,344**	**20,864**	**35,397**	**41,273**	**36,458**	**42,183**	**39,797**	**61,554**	**85,276**	**77,088**	**51,627**

(1) A cumulative count of individual health workers trained is not provided because some health workers have been trained on more than one occasion. (2) During FY 2012, USAID also provided support for case management activities in Burkina Faso and Burundi; 1,727 health workers were trained in ACT use. (3) During FY 2014, USAID also provided support for case management activities in Burkina Faso and South Sudan; 831 health workers were trained in ACT use. (4) During FY 2015, USAID also provided support for case management activities in Burkina Faso and Burundi; 959 health workers were trained in ACT use. (5) During FY 2016, USAID also provided support for case management activities in Burkina Faso, Burundi, and South Sudan; 1,594 health workers were trained in ACT use.

APPENDIX 3: MORTALITY RATES AND INTERVENTION COVERAGE IN PMI FOCUS COUNTRIES

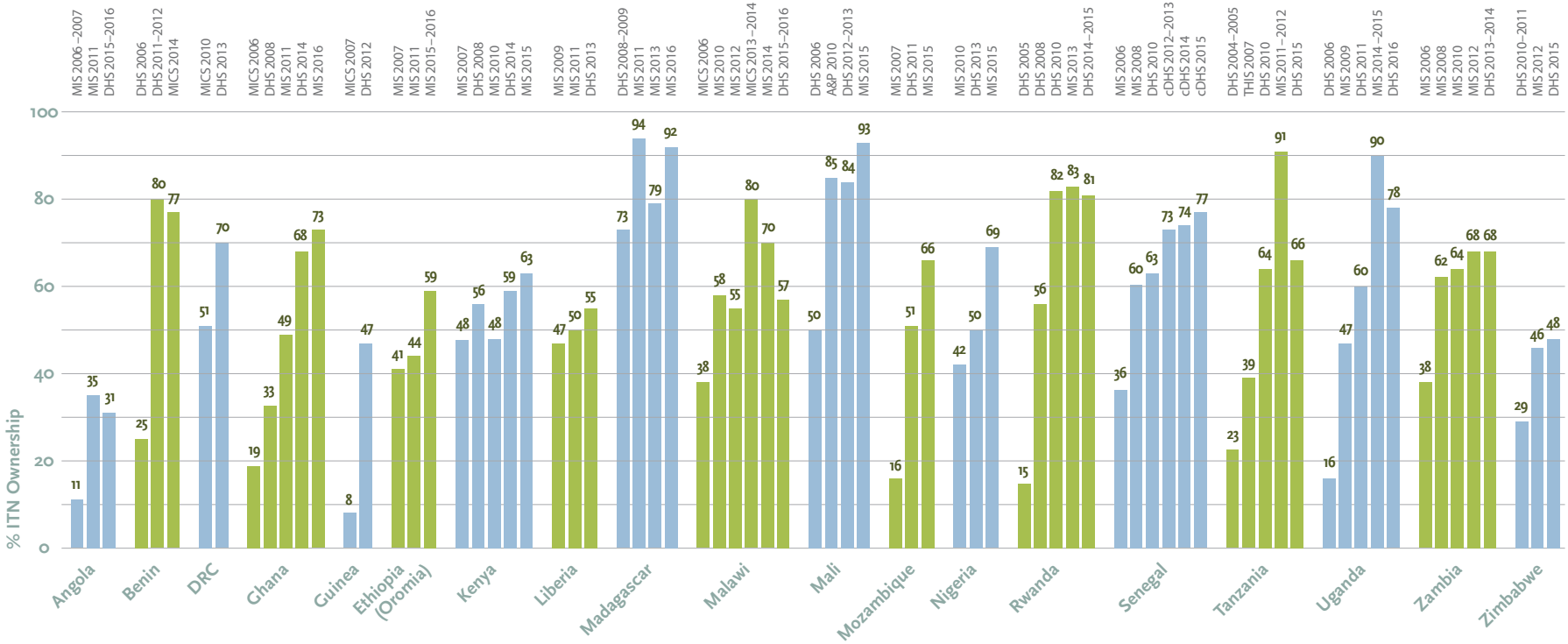
Figure 1. All-cause Mortality Rates among Children Under Five in PMI Focus Countries



(1) Both under-five mortality estimates for Angola are derived from the MIS 2011. The estimate 118/1,000 is for the period 2001–2006, while 91/1,000 is for the period 2006–2011. (2) The final report of the DHS 2011–2012 notes that, while mortality among children under five in Benin has declined, there may have been significant under-reporting of neonatal and child deaths by respondents.

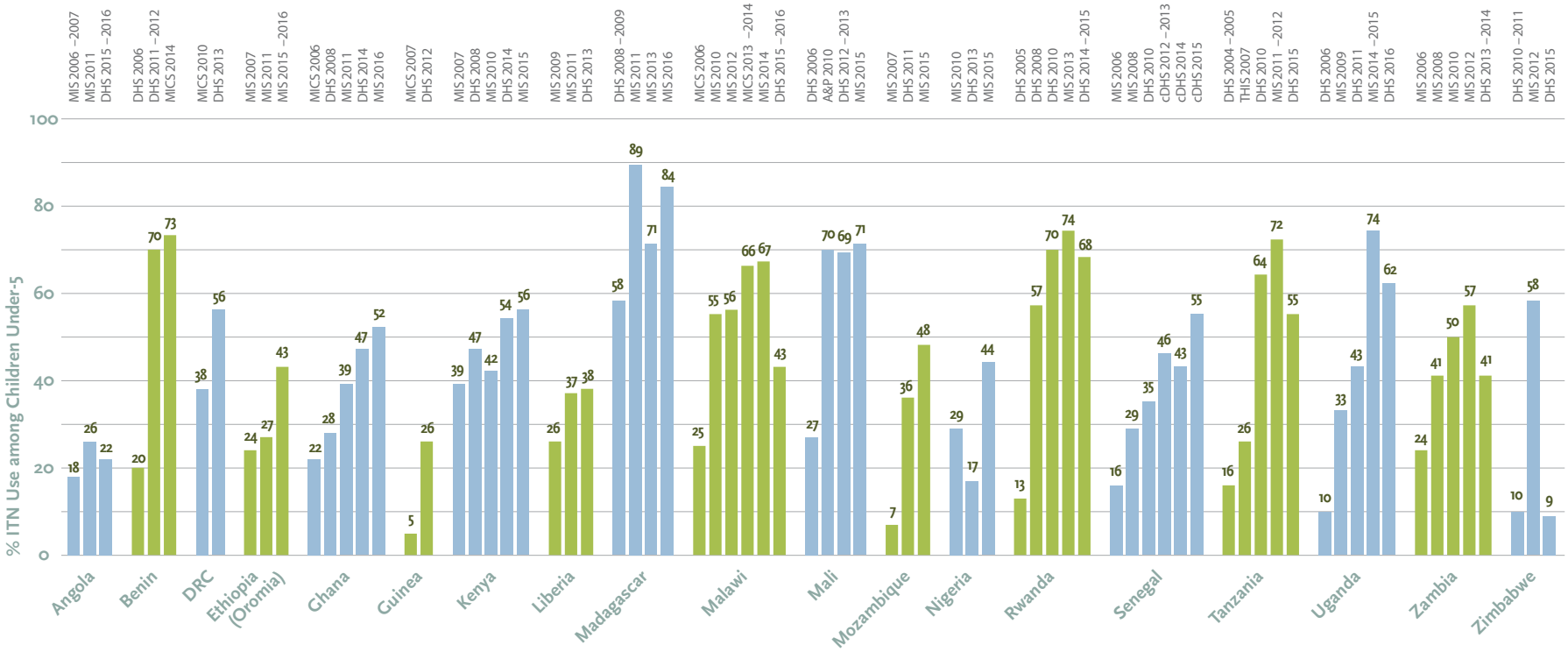
Note: Data points included in this figure are drawn from nationwide household surveys that measured all-cause mortality in children under the age of five.

Figure 2. ITN Ownership in PMI Focus Countries



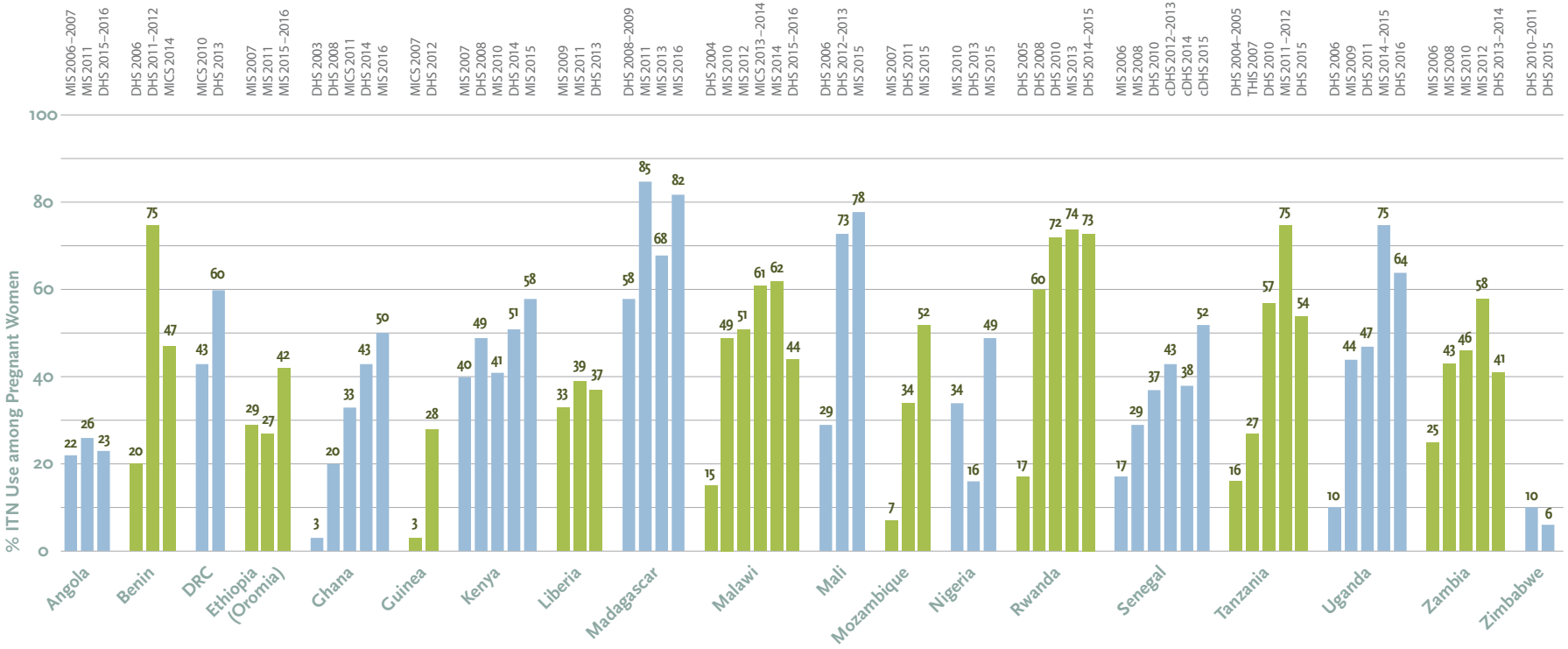
Note: Data points included in this figure are drawn from nationwide household surveys that measured ITN ownership, defined as the percentage of households that own at least one ITN.

Figure 3. ITN Use among Children Under Five in PMI Focus Countries



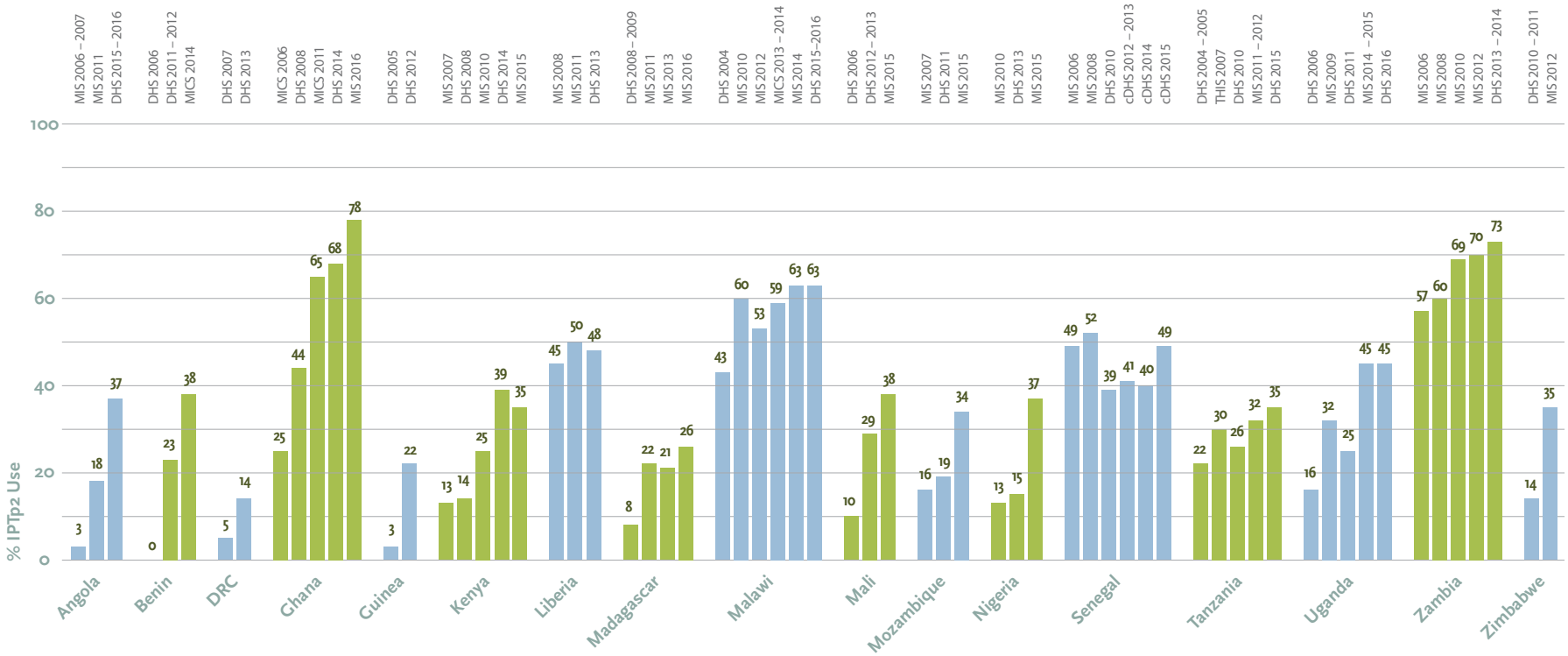
Note: Data points included in this figure are drawn from nationwide household surveys that measured ITN use among children under five, defined as the percentage of children under five who slept under an ITN the night before the survey.

Figure 4. ITN Use among Pregnant Women in PMI Focus Countries



Note: Data points included in this figure are drawn from nationwide household surveys that measured ITN use among pregnant women, defined as the percentage of pregnant women who slept under an ITN the night before the survey.

Figure 5. IPTp2 Rates in PMI Focus Countries



Note: Data points included in this figure are drawn from nationwide household surveys that measured IPTp2 coverage for pregnant women, defined as the percentage of women who received at least two doses of SP during their last pregnancy, with at least one dose given during an antenatal clinic visit. IPTp is not part of the national policy in Ethiopia and Rwanda.

ACKNOWLEDGMENTS
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U.S. PRESIDENT'S MALARIA INITIATIVE

U.S. Agency for International Development
1300 Pennsylvania Avenue, NW
Washington, DC 20523
Tel: (202) 712-0000
Fax: (202) 216-3524
www.usaid.gov