ROLL BACK
MALARIA

Guidelines
For Core Population-Based Indicators

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Acknowledgements

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Acronyms

ACT	Artemisinin-Based Combination Therapies
ANC	Antenatal Care
CHERG	Child Health Epidemiology Reference Group
DHS	Demographic and Health Survey
HB	Hemoglobin
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information Systems
IPT	Intermittent Preventive Treatment
IRS	Indoor Residual Spraying
ITN	Insecticide-Treated Nets
M&E	Monitoring and Evaluation
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
MIS	Malaria Indicator Survey
NGO	Non-Governmental Organization
PMI	President's Malaria Initiative
RBM	Roll Back Malaria
RDT	Rapid Diagnostic Test
SP	Sulfadoxine-pyrimethamine
SSA	Sub-Saharan Africa
U5MR	Under 5 Mortality Rate
UN	United Nations
UNICEF	United Nations Children Fund

1.   Introduction

1.1   Background

Malaria poses a tremendous public health problem across the globe with an estimated 40% of the world's population living in areas of malaria risk [1]. An estimated 190–330 million malaria episodes and at least 1 million malaria deaths occur annually [2]. While malaria is endemic within most tropical and subtropical regions of the world, 90% of all malaria deaths currently occur in sub-Saharan Africa (SSA) [3]. Young children and pregnant women represent those at greatest risk of malaria-related morbidity and mortality, especially in areas of stable transmission. It has recently been estimated that malaria is responsible for approximately 20% of all deaths among children less than 5 years of age in SSA [4]. Malaria also places an enormous toll on the already overburdened health systems across SSA and elsewhere, as it has been estimated that malaria-related illnesses account for approximately 30% of all outpatient clinic visits within malaria-endemic countries of the SSA region [5].

The last 10 years have seen a resurgence of interest in malaria as a disease of major public health importance. To coordinate the efforts of the international community, the Roll Back Malaria (RBM) partnership was launched in 1998, with the goal of halving the burden of malaria by 2010. Under the auspices of RBM, the heads of state from across Africa met in Abuja, Nigeria in 2000 to express their commitment to combating malaria and established the first set of concrete, measurable goals for national malaria control strategies. As part of the Roll Back Malaria Partnership, the United Nations family of organizations has also emphasized malaria control in recent initiatives. The UN declared 2001–2010 the "Decade to Roll Back Malaria" in developing countries, particularly in Africa, and set malaria as a high priority within the United Nations (UN) Millennium Development Goals. In May 2002, the strategies for protecting children and pregnant women from malaria were also adopted by the UN General Assembly's Special Session on Children (A World Fit for Children).

In order to respond to the medical, public health, and economic burden of this disease, international funding for malaria control has greatly increased over the last several years [6]. The Global Fund to Fight AIDS, Tuberculosis, and Malaria was created in 2002 and has committed over $1.7 billion for malaria programs in over 76 recipient countries between 2002 and 2007. In 2005, both the World Bank's Malaria Control Booster Program and the U.S. President's Malaria Initiative (PMI) were established. The Booster program reflects an eight-fold increase in World Bank malaria funding in Africa, and the PMI is a $1.2 billion five year initiative coordinated with national malaria control programs. Additionally, the Bill and Melinda Gates Foundation committed $83.5 million in new malaria grants in 2006, which will support malaria prevention and treatment programs as well as research and development [7].

Table 1:

RBM Technical Strategies, Associated RBM Global Strategic Plan and PMI Targets, and MDG Goal and Indicators

Overall Goal	Roll Back Malaria Partnership	President's Malaria Initiative	Millennium Development Goal
Impact Target to be Assessed	Halve malaria burden between 2000 and 2010	50% reduction in malaria mortality in 15 focus countries during five year period (2005-2010)	To halt and begin to reverse the incidence of malaria by the target date of 2015
RBM Technical Strategies	**RBM Global Strategic Plan Targets (by 2010)**	**PMI Coverage Targets (by 2010)**	**MDG Indicators**
Vector control via insecticide-treated nets (ITNs)	80% of people at risk from malaria are using locally appropriate vector control methods such as long-lasting insecticidal nets (LLINs), indoor residual spraying (IRS) and, in some settings, other environmental and biological measures	85% of children under five and pregnant women will have slept under an ITN the previous night	Incidence and death rates associated with malaria
Prompt access to effective treatment	80% of malaria patients are diagnosed and treated with effective anti-malarial treatments	85% of children under five with suspected malaria will have received treatment with ACTs within 24 hours of onset of their symptoms	Proportion of children under 5 sleeping under insecticide-treated bednets
Prevention and control of malaria in pregnant women	In areas of high transmission, 100% of pregnant women receive IPT	85% of women who have completed a pregnancy in the last two years will have received two or more doses of IPT during that pregnancy	Proportion of children under 5 with fever who are treated with appropriate anti-malarial drugs

Adapted Breman 2007, PMI Second Annual Report and RBM Global Strategic Plan, 2005-2015 [3, 8, 9]

This increase in available resources has allowed endemic countries to rapidly increase coverage of malaria interventions. With this scale-up of control efforts, national monitoring and evaluation systems must be strengthened in order to ensure that such implementation efforts are as effective as possible. Furthermore, an effective system for monitoring progress and evaluating results will be critical for assessing the effectiveness of control strategies. Such data will be crucial for identifying areas where modifications in specific technical strategies may be needed, as well as where resources should be focused. To facilitate this process, the RBM partners have established a set of core indicators that can be collected through household surveys that permit national-level monitoring and evaluation of the technical strategies supported by RBM.

In addition, the recent calls for eradication and elimination will require increased vigilance for monitoring and evaluation systems. Routine surveys will continue to play an important role in monitoring sustained coverage of key interventions. Facility-based surveillance systems will need to be improved to track, diagnose and treat cases rapidly and effectively. National laboratory systems will be important to identifying imported versus indigenous cases and monitor parasite species mix. These and other refinements of national monitoring and evaluation systems will be critical to maintaining high levels of malaria control and tracking progress towards elimination and eventual eradication.

1.2   Purpose and Content of Manual

The purpose of this manual is to provide country partners with technical guidance on the detailed specifications of the core indicators that can be measured through household surveys, the data required for their construction, as well as issues related to their interpretation. Details of the data collection methods required for estimating these indicators through national-level household surveys are also provided. This manual is intended to maximize internal consistency and comparability of the indicators across countries and over time, and to ensure consistency in the types of data collection methods used.

It should be noted that the indicators and measurement tools described in this guide were developed in the context of the high malaria burden countries of Africa, where malaria is a generalized problem and programs target the segments of the population that are at greatest risk such as children under 5 and pregnant women. In other settings, such as South East Asia and Latin America, a more targeted approach to monitoring and evaluation is necessary and the use of large, nationally representative surveys to measure coverage may not be necessary or may be deployed less frequently. Likewise, the indicators to measure programs such as Insecticide-Treated Net (ITN) use, or Intermittent Preventative Treatment (IPT) in pregnant women, may not reflect the strategies used in Asia and Latin America. This guide specifically focuses on Africa because of the critical need to track the scale up of key interventions and provide evidence of their impact in this region of highest disease burden and greatest investment in malaria control. Guidance for the types of programs supported in other regions, such as drug efficacy/quality, and access to treatment for marginalized populations, will be dealt with in other publications.

This manual begins with a brief discussion on the basic principles of monitoring and evaluation. The outcome indicators that will be used to measure the success of the RBM technical strategies of ITNs, indoor residual spraying (IRS), prompt access to effective treatment, and

prevention and control of malaria in pregnant women are then listed. A brief discussion on the rationale for these RBM technical strategies is also provided. Next, three impact indicators are listed, followed by an explanation regarding the need for both morbidity and mortality measures. Discussions on measurement tools, methods of measurement, interpretation, and reporting of the indicators are then provided. The manual concludes with detailed guidelines for constructing each indicator.

Due to increased funding in the past few years, malaria control efforts have expanded rapidly and interventions have evolved with the changing funding climate. Therefore, the guidelines presented in this updated manual have changed substantially from those previously published in 2006. Notable changes include —

- An additional coverage indicator to assess the roll-out of diagnostic programs.
- An additional coverage indicator which provides a measure of the proportion of households covered by one or both of the two main vector control interventions, ITNs and IRS, now being used.
- The inclusion of three impact indicators: all-cause under 5 mortality, parasitemia prevalence among under 5 year olds, and anemia prevalence among under 5 year olds.

It should also be noted that in this version, many of the indicator descriptions in Section 4 are followed by a text box, which includes either a supplemental indicator or secondary analyses that may be appropriate to report under certain circumstances. The supplemental indicators may include a broader age group than the related core indicator, may be derived using different methods, or may be obtained from a data source other than household surveys (e.g. HMIS or program reports). The supplemental indicators obtained from other data sources may be necessary to measure the program coverage of a given intervention, as opposed to the national coverage which is measured by large-scale household surveys. For example, IRS program coverage may be more appropriate to measure in countries where spraying is not conducted throughout the entire country. While none of these indicators are being recommended as core indicators by the RBM partners, certain countries may find them pertinent and therefore information regarding their utility and comparability has been included.

2.   Monitoring and Evaluation

Evaluation is the use of social or epidemiological research methods to assess, and ideally improve, the implementation of public health programs. The overall goal of monitoring and evaluation (M&E) is to measure program effectiveness. M&E may be focused on local initiatives as well as measuring program effectiveness at the national and regional levels. Ideally, M&E tools can be used to demonstrate to planners and other decision-makers that program efforts have had measurable impacts on the outcomes of interest. M&E can also provide insight as to where resources are being used most efficiently versus where new strategies should be considered.

Monitoring is used to verify step-by-step the progress of malaria control programs at various levels to see whether activities have been implemented as planned, ensure accountability, detect problems and constraints related to the intervention activities, and promote evidence-based planning through timely feedback to the relevant authorities. Indicators of inputs, processes, and outputs are typically used for monitoring purposes at the program level. Input indicators are generally used to measure the level of resources available for use by the program or intervention, such as the funding obtained to purchase ITNs. Process indicators are generally used to verify that a program or intervention has been implemented as planned, such as verifying that ITNs have been purchased and are ready for distribution. It is expected that inputs and desired processes will lead to desired changes in output indicators, which are generally used to measure benchmarks of program-level performance, such as the number of ITNs distributed to a particular target population. Figure 1 provides an example schematic of the level and function of indicators typically used for M&E.
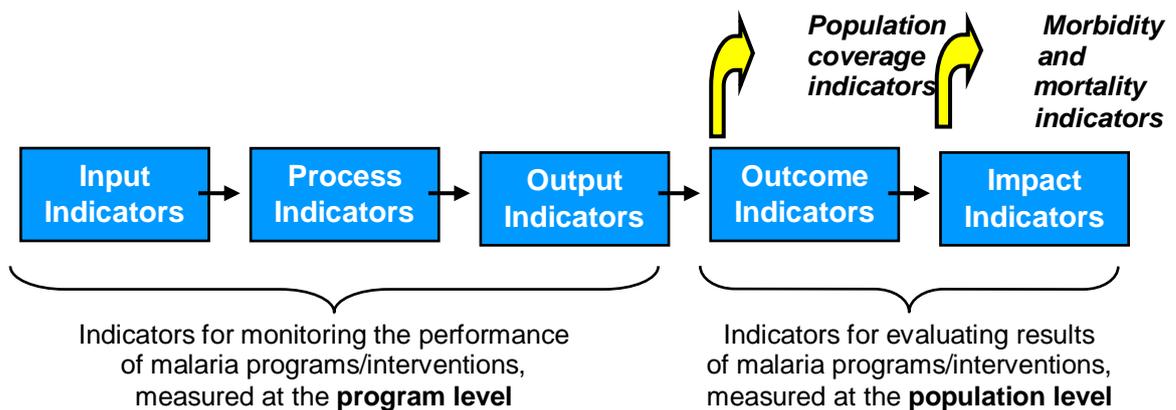
While monitoring is a continuous process, formal evaluation is required to determine and document the extent to which any expectant results are attributable to a particular malaria control program, as measured through outcome and impact indicators. Outcome indicators are generally used to measure medium-term population-level results, such as the level of ITN coverage among a particular target population that can be attributed to an ITN program or intervention. It is expected that desired changes in outcomes will lead to a desired impact, which generally refers to the overall, long-term goals of a program or initiative, such as the RBM goal of halving malaria-related morbidity and mortality by 2010.

Impact measurement is the ultimate goal, and often the most challenging aspect, of program evaluation, and this is particularly the case for malaria. True impact evaluation involves measuring changes in impact level indicators, such as morbidity and mortality, and empirically linking the observed change with a specific program or intervention. This type of evaluation requires rigorous experimental design to make a causal association between program inputs and the resulting impact measures. In the field of public health, where programs operate in the context of existing communities and not in controlled trial settings, evaluators rarely have this luxury. In addition, malaria-specific morbidity and mortality are very difficult to measure even in the best of situations. The signs and symptoms of malaria illness are non-specific and mimic many other childhood illnesses. Even with modern diagnostic tests (microscopy/RDT), the sensitivity and specificity of the tests can vary in different study settings. Malaria-specific mortality is even more difficult to measure given that most deaths occur in the home and definitive cause of death is not usually available.

For these reasons, the RBM Partnership places a strong emphasis on measuring changes in population-level coverage of the core indicators at the outcome level. There is substantial empirical evidence to support the efficacy of current technical strategies in different programmatic contexts. It is expected that increasing coverage of these key interventions will result in the desired reductions in morbidity and mortality. Therefore, it is crucial that countries implementing these interventions have clear definitions and appropriate tools for measuring the outcome indicators for population-level coverage as part of their overall monitoring and evaluation strategy. In addition, this guide provides basic information for measuring impact indicators, in order to allow countries to assess whether scale-up of the key interventions has resulted in the intended impact at the population level over the longer term.

Figure 1:

Level and Function of M&E Indicators

Population coverage indicators   *Morbidity and mortality indicators*

| Input Indicators | Process Indicators | Output Indicators | Outcome Indicators | Impact Indicators |

Indicators for monitoring the performance of malaria programs/interventions, measured at the **program level**

Indicators for evaluating results of malaria programs/interventions, measured at the **population level**

3. Core Indicators for Evaluating RBM Technical Strategies

3.1 Core Outcome Indicators

There are eight outcome indicators that will be used to measure the proportion of the population that is covered by the interventions outlined by the RBM technical strategies, as shown in Table 2. It is recognized that certain interventions, such as IPT and IRS, are not ongoing malaria control activities conducted outside of the African region, so certain indicators may not be pertinent to all RBM partner countries.

Table 2:

Indicators of Population Coverage for Evaluating RBM Technical Strategies

RBM Intervention	Indicator Description
Insecticide-treated nets (ITNs) and indoor residual spraying (IRS)	1. Proportion of households with at least one ITN.
	2. Proportion of children under 5 years old who slept under an ITN the previous night.
	3. Proportion of Households with at least one ITN and/or sprayed by IRS in the last 12 months.
	4. Proportion of children under 5 years old with fever in last 2 weeks who received any antimalarial treatment.
Prompt and effective treatment and use of diagnostics	5. Proportion of children under 5 years old with fever in last 2 weeks who received antimalarial treatment according to national policy within 24 hours from onset of fever.
	6. Proportion of children under 5 years old with fever in the last 2 weeks who had a finger or heel stick.
Prevention and control of malaria in pregnant women	7. Proportion of pregnant women who slept under an ITN the previous night.
	8. Proportion of women who received intermittent preventive treatment for malaria during ANC visits during their last pregnancy.

Insecticide-treated Nets and Indoor Residual Spraying

Under trial conditions, ITNs have been shown to reduce malaria transmission by as much as 90% [10], with concomitant reductions in malaria-related morbidity [11, 12]. Community randomized controlled trials have also shown ITNs to be associated with significant reductions in all-cause under 5 child mortality by as much as a third, across a range of malaria transmission settings in SSA [13, 14]. ITNs have also been shown to remain effective under field conditions, as it was shown that social marketing of ITN in Tanzania was associated with a 27% increase in survival, as well as 65% reduction in anemia, among children 1 month to 4 years old [15]. Efforts to scale up coverage of ITNs are underway in most African countries and are greatly assisted by efforts to remove associated taxes and tariffs on imported commodities [16].

IRS is the organized, timely spraying of an insecticide on the inside walls of houses or dwellings. It is designed to interrupt malaria transmission by killing adult female mosquitoes when they enter houses and rest on the walls after feeding, but before they can transmit the infection to another person [17]. IRS has been shown to be effective in reducing vectorial capacity and malarial disease in a wide variety of settings, and is particularly effective in locations where mosquitoes are indoor-resting and malaria is seasonally transmitted [18]. A coverage indicator is included to measure the proportion of households covered by either an ITN or by IRS. This indicator has been developed to address concerns regarding the small areas or 'target zones' that are sprayed with IRS in many countries, and the potential misinterpretation of a national-level IRS indicator that may result. By including ITN and IRS interventions in a single indicator, one can assess overall coverage of preventive control measures within the country.

Prompt Access to Effective Treatment and Use of Diagnostics

It is widely recognized that access to prompt and effective treatment is a key element in successful malaria control because of the rapid onset of illness and severe health outcomes related to Plasmodium falciparum malaria, especially among children and non-immune populations [16, 19]. However, antimalarial drug-resistance has become a major challenge in providing an effective malaria treatment within many regions of the world. Resistance to traditional monotherapies such as chloroquine, sulfadoxine-pyrimethamine, and amodiaquine, is now widespread across most of Africa. As a result, the World Health Organization now recommends treating malaria using artemisinin-based combination therapies (ACTs) ([7]. Understanding which antimalarial drugs are provided to children for fever, and the promptness with which they are received after the onset of symptoms, at the community level is an important component for monitoring prompt access to effective treatment.

The replacement of conventional antimalarial drugs with high-cost, artemisinin-based alternatives has created an increased need for accurate disease diagnosis. In addition to avoiding unnecessary treatment with these expensive drug combinations, diagnostics allow a more rational use of drugs that might effectively reduce drug pressure, thereby delaying the onset of drug resistance [20]. Consequently, baseline levels of diagnostic use and assessment of program scale-up needs to be measured during regularly conducted household surveys.

Prevention and Control of Malaria in Pregnant Women

Malaria infection during pregnancy is a major public health concern among adult populations across malaria endemic areas with stable transmission, such as tropical Africa. Malaria during pregnancy can result in poor outcomes for the woman and her newborn, such as maternal anemia, low birth weight, and premature delivery [21]. Low birth weight is the single greatest risk factor for neonatal mortality and a major contributor to infant mortality [22, 23]. This increased risk of adverse outcomes for mothers and their newborns is typically greatest for the mother's first two pregnancies. However, in the presence of HIV infection, the risk associated with placental malaria appears to be independent of the number of pregnancies [24].

Effective strategies for preventing and controlling malaria during pregnancy, such as the use of ITNs and IPT, have been shown to have a dramatic impact on the health of mothers and their newborns within areas of stable malaria transmission. ITN use has been shown to significantly reduce the prevalence of low birth weight deliveries, as well as malaria-related morbidity among pregnant women [16, 25]. At present, the standard IPT regimen is a therapeutic dose of sulfadoxine-pyrimethamine (SP) given at least twice after quickening to all pregnant women during routine antenatal care. IPT in two doses of SP during pregnancy has been shown to significantly reduce the prevalence of anemia and placental malaria infections at the time of delivery [26-28]. However, to achieve optimal benefit in settings with HIV prevalence in pregnant women of greater than 10%, it may likely be more cost effective to treat all women with a 3-dose regimen than to screen for HIV and provide this regimen only to HIV positive women [29].

SP efficacy for treatment of symptomatic malaria in children has declined in the last five years, raising concerns about its longevity for IPT during pregnancy. Consequently, studies are under way to determine the safety and efficacy of SP-IPTp, given the recent increase in SP resistance [30]. To date, SP has been shown to remain effective in this population of women, due to their substantial systemic immunity resulting from repeated exposure in the past. Consequently, even in settings where resistance has been observed, SP continues to provide substantial benefit to pregnant women [31]. Any subsequent changes to the WHO recommendations will be incorporated into future versions of this document and communicated as needed.

3.2   Core Impact Indicators

This updated version of the RBM core indicator guidelines also includes three impact indicators, as shown in Table 3. At a minimum, the RBM partners recommend that all countries with high-intensity malaria transmission regularly monitor all-cause under 5 mortality based on data from statistically-sound national-level household surveys, such as Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) [32].

Alongside data on mortality, it is recommended that countries also collect data on anemia and parasitemia to assess malaria morbidity among children under the age of five. Parasitemia prevalence is a useful morbidity indicator, as it is malaria-specific and can provide a rough measure of transmission [33]. Additionally, anemia prevalence is a reliable indicator of malaria morbidity that can reflect the impact of malaria interventions [34, 35]. The standard Malaria Indicator Survey (MIS) includes anemia and parasitemia biomarker measurements. The DHS also routinely collects anemia data from nationally representative samples.

Table 3:

Indicators for Evaluating Impact of RBM Technical Strategies

RBM Impact Measures	Indicator Description
Mortality Indicator	9. All-cause under 5 mortality rate (5q0).
Morbidity Indicators	10. Parasitemia Prevalence: proportion of children aged 6-59 months with malaria infection.
	11. Anemia Prevalence: proportion of children aged 6-59 months with a hemoglobin measurement of <8 g/dL

To evaluate impact, the RBM recommendation is to assess all-cause childhood mortality trends over a clearly defined time interval, and changes in malaria intervention coverage, the prevalence of other factors influencing malaria and non-malaria childhood mortality (vaccination coverage, malnutrition, etc), and morbidity indicators (anemia and parasitemia prevalence) are to be measured over the same time intervals to which the all-cause childhood mortality trends apply. If statistically significant reductions in mortality and morbidity are found *and* malaria intervention coverage has increased to high levels *and* other factors influencing all-cause childhood mortality have not changed substantially, then it is a plausible conclusion that malaria control activities caused or contributed to reductions in malaria-associated mortality. A more detailed description of this general evaluation method and its incorporation of a plausibility argument have recently been described elsewhere [36].

Countries are also advised to use coverage estimates of key malaria control interventions as inputs to the Lives Saved Tool (LIST), which is a user-friendly software package developed by the Child Health Epidemiology Reference Group (CHERG). Based on these inputs, the model can predict the impact of malaria control programs on mortality among African children. Finally, verbal autopsies attached to household surveys may be able to provide information on malaria-specific mortality. However, operational research is needed to determine the validity of data collected using this tool before it can be recommended.

3.3 Measurement Tools

Nationally representative, population-based sample surveys are the principal measurement tools required to collect the necessary data for constructing all eight core outcome indicators, as well as the three core impact indicators. Three large survey efforts that currently collect data on malaria are the DHS, the MICS, and the MIS.

Demographic and Health Surveys: The DHS surveys are nationally representative, population-based sample surveys that are routinely undertaken in many countries of SSA every 4-5 years to collect data on a wide variety of demographic and health indicators. Importantly, the DHS surveys are designed to produce data that are comparable over time and across countries. The DHS survey includes a household register for the ascertainment of the age, sex, and relationship to the head of household for all individuals within selected households. The DHS surveys are typically designed to provide relatively precise population-level estimates by age groups, sex, urban/rural residence, and regions. The DHS survey package includes an optional module for malaria that allows the collection of necessary data for the construction of

the RBM core indicators. Published reports, questionnaires, and materials related to the DHS surveys can be found online at http://www.measuredhs.com.

Multiple Indicator Cluster Surveys: The MICS surveys are nationally representative, population-based sample surveys developed by the United Nations Children Fund (UNICEF) to support countries in filling critical data gaps for monitoring the situation of children and women. Initially designed to collect indicators marking progress toward the World Summit for Children goals, the MICS surveys have continued to be an important component of national data collection in many countries. The MICS surveys are conducted in rounds approximately every three years, and since its inception in 1995, nearly 200 surveys have been conducted in approximately 100 countries worldwide. Importantly, the MICS surveys are designed to produce data that are comparable over time and across countries, and are harmonized with data collected through other major household survey programs, such as DHS and MIS. The MICS survey package includes an optional module for malaria that allows the collection of necessary data for the construction of the RBM core indicators, with the exception of ITN use among pregnant women. Published reports, questionnaires, and datasets related to the MICS surveys can be found online at http://www.childinfo.org.

Malaria Indicator Survey (MIS): In addition to these ongoing survey efforts, the RBM partners have developed a standard MIS survey package for assessing the key household coverage indicators and morbidity indicators. This includes a core questionnaire and data tabulation plan, as well as related materials for organizing and conducting fieldwork. This stand-alone survey is designed to be implemented in a similar manner to the DHS surveys, producing nationally representative, population-based data from which the core RBM indicators can be constructed. The MIS survey will also produce a wide range of data for in-depth assessment of the malaria situation within countries. The MIS survey questionnaire and other related materials can be found online at http://www.rbm.who.int/merg.html.

It is recommended that the eleven core RBM indicators be measured using either the DHS or MICS surveys because of their sampling design rigor and reliability over time and across countries. Furthermore, a comprehensive package of demographic data is collected during both of these surveys, which allows additional analyses to be conducted. However, these surveys are only implemented every 3-5 years. If immediate data collection is required that does not fit within the implementation schedule of either the DHS or MICS surveys within a particular country, it is recommended that the MIS survey be used to obtain the necessary data for measuring the core RBM indicators. This will ensure their comparability with the DHS and MICS surveys over time and across countries.

3.4   Method of Measurement and Data Collection

There are several general issues pertaining to method of measurement and data collection that are relevant to all eleven core indicators. As stated, it is recommended that the data used for constructing the core indicators be measured through nationally representative household sample surveys, such as the DHS, MICS, or MIS surveys. However, to remain consistent with global targets, the coverage indicators are intended to be measured among the population "at risk for malaria," which in some instances may create implications for survey design.

To ensure that standard statistical methods can be used to estimate the core indicators and their accompanying standard errors, it is recommended that scientific sampling procedures follow similar methods to those used by the DHS, MICS, or MIS surveys. Such procedures typically entail a two-stage cluster sampling design with primary sampling units selected with probability proportional to size.

Additionally, these samples are typically stratified by region, and by urban/rural residence, as stipulated by survey objectives. For further details of this general type of sampling method, please refer to the sampling guidelines for the DHS, MICS, or MIS surveys, which can be found online at: http://rbm.who.int/merg.html.

Both the DHS and MICS surveys typically include all primary sampling units for an entire country in their sampling frames to ensure nationally representative estimates. In countries with endemic or epidemic-prone malaria throughout, it is appropriate to include all primary sampling units within the country in the sampling frame, given that pre-stratification by urban and rural residence is also undertaken, as is the case with the DHS and MICS surveys. If a DHS or MICS survey is to be used for obtaining the core indicators within countries with defined areas without endemic or epidemic-prone malaria, such as those with mountainous areas or deserts, it should be noted that national estimates will include populations not at risk for malaria. This will need to be taken into account when interpreting national-level indicators for some countries. Please refer to the **MIS Sampling Guidelines** for a more detailed description of how best to construct a sampling frame for countries with widely varying levels of malaria endemicity available at: http://rbm.who.int/partnership/wg/wg_monitoring/docs/mis2005/cc8.pdf.

3.5 Interpretation

There are two particular issues that will likely affect the interpretation of all eleven core RBM indicators to be obtained from household surveys.

Malaria Endemicity

The first issue that may affect the interpretation of the core indicators involves the definition of the target population. As stated previously, the RBM targets stipulate that the coverage indicators are intended to be measured among the target population defined as those at risk for malaria. For countries where malaria is endemic or epidemic-prone throughout, this issue should not be of particular concern as long as stratification by urban and rural residency is undertaken, as is typically the case with the DHS, MICS, and MIS surveys. However, within countries that contain large populations in areas absent of malaria, such as those with mountainous areas or deserts, national-level estimates, such as those obtained from the DHS and MICS surveys, will likely result in an underestimate of coverage for those at risk for malaria. In such a situation, it may be advisable to collect additional information that can establish whether an enumeration area is within or outside a malaria risk area; then during data analysis one can limit the analysis to survey domains that are deemed to be malarious. If this is not possible, data should be interpreted accordingly.

Despite the difficulties associated with varying levels of endemicity, progress in malaria intervention coverage is generally monitored at the national level in high malaria burden countries in Africa, rather than among sub-national at-risk populations. There are many important reasons for relying on national-level estimates of malaria intervention coverage. For many countries it is difficult to accurately define at-risk areas and subsequently identify

households surveyed within those areas since surveys do not always geo-code the households or villages where survey interviews occur [7]. Additionally, the at-risk population will continue to change, and therefore it would be difficult to measure progress with the indicators proposed. Finally, if a strategy is being implemented in an effort to achieve elimination, high coverage levels must be sustained at the national level in order to continue to control malaria and prevent against future resurgence of the disease.

Consequently, indicator estimates obtained from DHS and MICS surveys will not be expected to correspond specifically to malaria endemic areas, but will be nationally-representative, even in those countries with non-malarious regions. The MIS guidelines should be consulted in order to incorporate an appropriate subsampling design in those countries which include non-malarious regions.

Seasonality

A second consideration that affects the interpretation of the survey findings is the timing of survey implementation relative to the malaria transmission season (rainy and early-post-rainy seasons). Generally speaking, MIS surveys are conducted during or immediately after the rainy season, and should begin no later than six weeks after the rains end, as this timeframe is associated with peak transmission. However, for operational reasons both DHS and MICS surveys are conducted during the dry season and therefore outside of the peak malaria transmission period. As intervention coverage or usage levels may differ significantly between seasons, and malaria morbidity and mortality will differ by season, interpretations of the data obtained must take into account the seasonality of the survey period. Further analysis of these data is needed to better understand the extent of the relationship between survey timing and intervention coverage.

Notes on significant assumptions and potential biases associated with specific indicators are provided separately in Section 4 under the description of each indicator.

4.   Guidelines for Constructing each Core RBM Outcome Indicator for Population Coverage

4.1   Vector Control via ITNs

1.   Proportion of Households with at Least One ITN[1]

- **Numerator:** Number of households surveyed with at least one ITN.

- **Denominator**: Total number of households surveyed.

Purpose

This indicator will be used to measure household ITN possession among the population at the national level.

Method of Measurement

This indicator requires data collected at the household level from nationally representative sample surveys. The MIS guidelines should be consulted for guidance on constructing a sampling frame and conducting data analyses for countries with varying levels of malaria endemicity. It is important that these data be collected on a household questionnaire, rather than on an individual questionnaire, as the individuals interviewed may not be representative of household possession. It is also important that surveys be conducted with sufficient design and sample size to allow comparisons among regions and urban/rural strata at the household level. The numerator for this indicator is obtained from asking household respondent if there is any mosquito net in the house that can be used to avoid being bitten while sleeping, and from determining whether it is a factory treated net that does not require any treatment, a pretreated net obtained within the past 12 months, or a net that has been soaked with insecticide within the past 12 months. The denominator is simply measured by the total number of surveyed households.

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[1] An ITN is 1) a factory treated net that does not require any treatment, 2) a pretreated net obtained within the past 12 months, or 3) a net that has been soaked with insecticide within the past 12 months.

Interpretation

This indicator provides a proxy measure for household ITN use at the national level.

Strengths	- The limited number of questions required to ascertain data for this indicator can be easily added to any nationally representative sample survey of households. - Presence of a net is typically verified at time of interview. - Comparable across countries given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for.
Limitations	- Because of issues of date recall of last impregnation, this indicator may not provide reliable estimates of net retreatment status. - May be difficult to interpret at the national level unless stratified by urban and rural strata as malaria transmission is most often localized. - Typically, no information is collected on whether the insecticide used to treat the net is an "approved" insecticide. - No information is collected on whether the net was washed after treatment, which can reduce its effectiveness.

2.   Proportion of Children under 5 Years Old who Slept under an ITN[2] the Previous Night

- **Numerator**: Number of children under 5 years old who slept under an ITN the previous night.

- **Denominator**: Total number of children under 5 years old who spent the previous night in surveyed households.

Purpose

This indicator will be used to measure the level of ITN coverage of children under 5 years old who are at the national level.

Method of Measurement

This indicator requires data collected from nationally representative household sample surveys. The MIS guidelines should be consulted for guidance on constructing a sampling frame and conducting data analyses for countries with varying levels of malaria endemicity. It is important that the survey contain a household listing that captures all children under 5 years old within each surveyed household. Additionally, surveys should be conducted with sufficient design and sample size to allow comparisons among regions and urban/rural strata.

The data for the denominator are obtained from the household questionnaire that lists every child under 5 who slept in the house the previous night. The data for the numerator are then obtained from a listing of the same children in the house who slept under a mosquito net the previous night, in combination with information on whether it is a factory treated net that does not require any treatment, a pretreated net obtained within the past 12 months, or a net that has been soaked with insecticide within the past 12 months.

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[2] An ITN is 1) a factory treated net that does not require any treatment, 2) a pretreated net obtained within the past 12 months, or 3) a net that has been soaked with insecticide within the past 12 months.

Interpretation

This indicator provides a direct measure of ITN use by children under 5 years of age at the national level.

Strengths	- The limited number of questions required to ascertain data for this indicator can be easily added to any nationally representative sample survey of households. - Presence of a net is typically verified at time of interview. - Comparable across countries given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for.
Limitations	- Because of issues of date recall of last impregnation, this indicator may not provide reliable estimates of net retreatment status. - May be difficult to interpret at the national level unless stratified by urban and rural strata as malaria transmission is most often localized. - May be biased by the seasonality of survey data collection, which is most often done during the dry season when net use is likely at its lowest. - Typically, no information is collected on whether the insecticide used to treat the net is an "approved" insecticide. - No information is collected on whether the net was washed after treatment, which can reduce its effectiveness.

Supplemental ITN Indicator

<u>ITN Usage among All Age Groups</u>

Proportion of Individuals who Slept under an ITN the Previous Night

- **Numerator:** Number of individuals who slept under an ITN the previous night.

- **Denominator**: Total number of individuals who slept in surveyed households the previous night.

In certain instances, calculating the proportion of all household residents using an ITN may be deemed necessary. It is useful to track usage among all ages since coverage of entire populations will be required to accomplish large reductions of malaria burden. While vulnerable groups, such as children under 5 years old and pregnant women, should still be prioritized, the equitable and communal benefits of wide-scale ITN use by older children and adults should be promoted and evaluated by national malaria control programs [37]. Furthermore, in areas of low endemicity, extending the age group is not only relevant, since more cases occur among individuals older than five years than among those under 5 years of age, but also sensible since fewer households would have to be visited to obtain the desired number of eligible interviewees. A supplemental ITN indicator would allow ITN usage for the entire population to be tracked.

4.2   Indoor Residual Spraying

3.   Households Covered by Vector Control

Proportion of Households with at Least One ITN[3] and/or Sprayed by IRS in the Last 12 Months

> - **Numerator:** Number of households that have at least one ITN and/or have been sprayed by IRS in the last 12 months.
>
> - **Denominator:** Total number of households surveyed.

Purpose/Rationale

This indicator allows overall national coverage of the two main vector control activities to be assessed. It will be used to measure the proportion of households covered by either an ITN or by IRS. In places where IRS is limited to small target areas, this indicator provides a more appropriate assessment of the vector control activities being conducted throughout the country than an indicator measuring national coverage of IRS activity alone.

Method of Measurement

This indicator requires data collected from nationally representative household sample surveys. The data for the numerator are obtained from information on which households possess an ITN, in combination with information on whether the household has been protected by IRS in the last twelve months. The denominator is simply the total number of households in the survey.
In those countries which have already begun to gather IRS information through MIS, this indicator can be calculated with currently existing survey questions and can be tabulated retroactively using past survey data. However, additional questions will have to be added to those survey questionnaires (e.g. DHS, MICS) which have not included questions on IRS in the past.

An IRS campaign may be conducted either as part of the national strategy for malaria control (operations conducted by governmental spray teams) or undertaken by an NGO or private company. It is important to capture only those spraying activities that have occurred as part of an organized IRS campaign, and to exclude spraying that was conducted by a member of the household.

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[3] An ITN is 1) a factory treated net that does not require any treatment, 2) a pretreated net obtained within the past 12 months, or 3) a net that has been soaked with insecticide within the past 12 months.

Interpretation

This indicator provides a proxy measure of national ITN and IRS coverage.

Strengths	- The IRS data for this indicator is already collected during MIS surveys, and the limited number of questions required to ascertain this data can be easily added to other surveys. - Presence of a mosquito net is typically verified at time of interview. - This indicator has been developed to address concerns regarding the small areas or 'target zones' that are sprayed with IRS in many countries, and the potential misinterpretations of a national-level IRS indicator that may result. By including ITN and IRS interventions in a single indicator, one can assess overall vector control coverage within the country.
Limitations	- Recall bias is likely to affect this indicator, as the issue of asking respondents to recall when the household was sprayed can result in considerable bias and 'heaping' of dates. - Additionally, the actual respondent may not have been present at the time of spraying and may therefore be reporting what was heard from others. - Estimate may be biased upwards if the respondent confuses spraying with residual insecticide with household products; however, such confusion can be reduced by thorough training of interviewers.

Supplemental IRS Indicators

Program-level Indicators

Reliable program data, obtained during routine spraying activities, is crucial for evaluating the performance of IRS programs. Given that household survey data has limitations such as recall bias and results at the national level may be misleading, program data should be collected in order to more accurately assess the progress achieved by spraying programs to date. To facilitate this process, program-level indicators may need to be reported as part of the national-level monitoring and evaluation plan.

Two such indicators are outlined in detail in a separate document [18].

<u>*National-level IRS Indicator*</u>

In addition to the indicator listed above, in countries where sizeable IRS operations are underway it may be advantageous to report IRS coverage at the national level. Data obtained from household surveys would be used, and therefore careful interpretation of the results is required, since achieving high levels of IRS coverage at the national level is not always the intent of programs. Since the denominator does not specifically include those areas where a program has intended to spray, this indicator cannot be used to evaluate the *performance* of a national IRS program. In some countries, relatively small areas or 'target zones' are specifically targeted for spraying, so taking a nationally-representative sample may misrepresent the extent to which IRS targets have been achieved, as low nation-wide coverage is not necessarily an indication of a poorly-performing IRS program. However, this data is necessary to collect in order to calculate the core indicator listed above. Furthermore, it may be deemed necessary to report on this indicator in certain countries due to reporting requirements, consistency between years, and sampling considerations.

A national-level IRS indicator is outlined in detail on page 25.

Proportion of Households which Received Spraying through an IRS Campaign within the Last 12 Months

- ▪ **Numerator:** Number of households that were sprayed with a residual insecticide during an IRS campaign in the last 12 months.
- ▪ **Denominator:** Total number of households surveyed.

Purpose/Rationale

The purpose of this indicator is to measure IRS coverage at the national level. The intent is to obtain information on overall coverage with IRS, rather than information on the quality of spraying activities.

Method of Measurement

Household survey questions for measuring population-level IRS coverage from a DHS, MICS, or MIS survey can be used to obtain the necessary information. This indicator can therefore be constructed from any household survey which includes such questions and covers areas where spraying is expected to have occurred.

An IRS campaign may be conducted either as part of the national strategy for malaria control (operations conducted by governmental spray teams) or undertaken by an NGO or private company (operations conducted independent of the national strategy). It is important to capture only those spraying activities that have occurred as part of an organized IRS campaign rather than spraying that was conducted by a member of the household.

The ideal household survey would be a MIS which has coverage sufficient to include a large proportion of all areas intended for spraying by the national program. If the household survey used for collecting data for this indicator does not specifically use a survey population defined as those at risk for malaria, care must be taken to ensure a sufficient sample size is obtained within malaria endemic areas of the country. It may also be necessary to over-sample within certain districts with known levels of malaria transmission, and known levels of IRS activity, for comparison purposes and to aid with interpretation.

Interpretation

This indicator provides a proxy measure of IRS coverage at the national level over a 12-month time period.

Strengths

- ▪ General coverage indicator that provides a national program with an estimate of the proportion of all households that report that their household has been sprayed.
- ▪ 12 month timeframe captures spraying prior to rainy season.

Limitations

- ▪ Recall bias is likely to affect this indicator, since asking respondents to recall when the household was sprayed can result in considerable bias and 'heaping' of dates.
- ▪ Additionally, the actual respondent may not have been present at the time of spraying and may therefore be reporting what was heard from others.
- ▪ Estimate may be biased upwards if the respondent confuses spraying with residual insecticide with household products; however, such confusion can be reduced by thorough training of interviewers.

4.2   Prompt Diagnosis and Effective Treatment (among children and 5 years old)

4.   *Proportion of Children under 5 Years Old with Fever in Last 2 Weeks*
       who Received Any Antimalarial Treatment

- **Numerator:** Number of children under 5 years old who had a fever in previous 2 weeks who received any antimalarial treatment.

- **Denominator:** Total number of children under 5 years old who had a fever in previous 2 weeks.

Purpose

This indicator captures the national-level access to antimalarial treatment for malaria.

Method of Measurement

This indicator requires data collected from nationally representative household sample surveys. The MIS guidelines should be consulted for guidance on constructing a sampling frame and conducting data analyses for countries with varying levels of malaria endemicity.

The data for the denominator are obtained in one of two ways, depending on the type of survey used. Some surveys use the household listing procedure when every child under 5 who slept in the house the previous night is identified (MICS). Other surveys ask questions in the women's questionnaire about all of their children under the age of 5, thus the denominator includes the children of women of reproductive age (who slept in the house the night before the survey) who had a fever in the previous two weeks. The numerator is then obtained by asking all mothers and/or caregivers (depending on survey method) in the household whether any of the children who had a fever in the past 2 weeks were given an antimalarial treatment.

Nearly all countries in SSA have shifted their national drug policies to highly effective artemisinin-based combination therapies; however, a large proportion of children with fever are still treated with less effective traditional monotherapies. This indicator captures children receiving such treatment. Consequently, the proportion of children treated with any antimalarial will be significantly higher than the proportion treated with effective antimalarials. Therefore, this indicator should be carefully interpreted.

Interpretation

This indicator provides a proxy measure of national ITN and IRS coverage. This indicator provides a proxy measure for the level of access of children under 5 years old to treatment for malaria infections, at the national level.

Strengths	▪ The limited number of questions required to ascertain data for this indicator can be easily added to any nationally representative sample survey of households. ▪ Comparable across countries given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for.
Limitations	▪ Fever may not have been the result of malaria infection. ▪ Because of issues of date recall, indicator may not provide reliable estimates of episodes of fever within previous 2 weeks or the identity of which specific drug was given. ▪ There is no way of knowing if antimalarial treatments were administered correctly. ▪ Data based solely on the mother's or caretaker's information may miss fostered children or others living in a household without a parent/caretaker.

5. Proportion of Children under 5 Years Old with Fever in Last 2 Weeks who Received Antimalarial Treatment According to National Policy within 24 Hrs from Onset of Fever

> - **Numerator:** Number of children under 5 years old who had a fever in previous 2 weeks who received recommended antimalarial treatment according to national policy <24 hours from onset of fever.
>
> - **Denominator:** Total number of children under 5 years old who had a fever in previous 2 weeks.

Purpose

This indicator captures the national-level access to prompt and effective treatment for malaria. Prompt and effective treatment within 24 hours of the onset of symptoms is necessary to prevent life-threatening complications [7].

Method of Measurement

This indicator requires data collected from nationally representative household sample surveys. The MIS guidelines should be consulted for guidance on constructing a sampling frame and conducting data analyses for countries with varying levels of malaria endemicity.

The data for the denominator are obtained in one of two ways, depending on the type of survey used. Some surveys use the household listing procedure when every child under 5 who slept in the house the previous night is identified (MICS). Other surveys ask questions in the women's questionnaire about all of their children under the age of 5, thus the denominator includes the children of women of reproductive age (who slept in the house the night before the survey) who had a fever in the previous two weeks. The numerator is then obtained by asking all mothers and/or caregivers (depending on survey method) in the household whether any of the children who had a fever in the past 2 weeks were given an antimalarial treatment.

The specific drug given and the timing of treatment relative to the onset of fever must also be recorded. The appropriate treatment to be used depends on the local drug efficacy spectrum, and is operationally defined as all first-line antimalarial drugs that were included in the national drug policy for treatment of uncomplicated pediatric malaria at the time the survey was conducted.

Since 2003, nearly all countries in SSA have shifted their national drug policies to highly effective ACTs. Consequently, the region has entered a dynamic transition period, shifting from conventional antimalarial monotherapies to ACTs. As such, present-day delivery of antimalarials is likely to be a combination of newly-recommended ACTs and previously-used monotherapies. Hence, the figures reported for this indicator may be low initially, but will likely increase as financing, procurement, and delivery of ACTs continues to increase [7].

The reference to 'effective treatment' above is not intended to mean the effectiveness of a dosing regimen. Rather, this indicator is meant to assess program coverage: at a minimum, children should be treated with those drugs included in the national antimalarial drug policy. While it is not possible to truly measure the effectiveness of the treatment delivered, whether children receive those drugs recommended for malaria treatment does measure one factor contributing to effectiveness.

Interpretation

This indicator provides a proxy measure for the level of access of children under 5 years old to prompt and effective treatment for malaria infections, according to national guidelines, at the national level.

Strengths	- The limited number of questions required to ascertain data for this indicator can be easily added to any nationally representative sample survey of households. - Comparable across countries given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for.
Limitations	- Fever may not have been the result of malaria infection. - Because of issues of date recall, indicator may not provide reliable estimates of episodes of fever within previous 2 weeks, the length of time after onset of fever before an antimalarial drug was given, or the identity of which specific drug was given. - There is no way of knowing if antimalarial treatments were administered correctly. - Data based solely on the mother's or caretaker's information may miss fostered children or others living in a household without a parent/caretaker. - May be difficult to compare across countries with different antimalarial drug policies; however, many countries have now adopted guidelines which recommend use of artemisinin-based combination therapy, resulting in greater consistency between policies.

6.   Proportion of Children under 5 Years Old with Fever in Last 2 Weeks who had a Finger or Heel Stick

- **Numerator:** Number of children under 5 years old who had a fever in the previous 2 weeks who had a finger/heel stick.

- **Denominator:** Total number of children under 5 years old who had a fever in the previous 2 weeks.

Purpose

The replacement of conventional antimalarial drugs with high-cost, artemisinin-based alternatives has created an increased need for accurate disease diagnosis. In addition to avoiding unnecessary treatment with these expensive drug combinations, diagnostics allow a more rational use of drugs that might effectively reduce drug pressure, thereby delaying the onset of drug resistance. This indicator is intended to capture baseline-level coverage and subsequent scale-up of diagnostic programs.

Method of Measurement

This indicator requires data collected from nationally representative household sample surveys. The MIS guidelines should be consulted for guidance on constructing a sampling frame and conducting data analyses for countries with varying levels of malaria endemicity.

The data for the denominator are obtained in one of two ways, depending on the type of survey used. Some surveys use the household listing procedure when every child under 5 who slept in the house the previous night is identified (MICS). Other surveys ask questions in the women's questionnaire about all of their children under the age of 5, thus the denominator includes the children of women of reproductive age (who slept in the house the night before the survey) who had a fever in the previous two weeks. The numerator is then obtained by asking all mothers and/or caregivers in the household whether any of the children who had a fever in the past 2 weeks received a finger/heel stick.

Interpretation

This indicator provides a proxy measure for the level of access of children under 5 years old to diagnostics for malaria infections, at the national level.

Strengths	▪ The limited number of questions required to ascertain data for this indicator can be easily added to any nationally representative sample survey of households. ▪ Comparable across countries given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for.
Limitations	▪ Because of issues of date recall, indicator may not provide reliable estimates of episodes of fever within previous 2 weeks. ▪ Fever may not have been the result of malaria infection. ▪ Finger/heel stick may not have been conducted to diagnose malaria (for instance, these methods are also used to diagnose anemia). However, the most likely purpose for this age group is malaria testing, especially subsequent to fever, so this should not be of considerable concern. The mother is not specifically asked whether the finger/heel stick was conducted for malaria testing due to concerns that an underestimate would result, as some women may not know whether the sample drawn was used for malaria diagnosis. ▪ Data based solely on the mother's or caretaker's information may miss fostered children or others living in a household without a parent/caretaker.

Additional Note: Presumptive Treatment Recommendations

In high and moderate malaria transmission areas where infection is common, the World Health Organization recommends that all children under the age of five with fever be treated with antimalarial medicines based on a clinical diagnosis—that is, presumptively, based on presentation of the signs and symptoms of the disease [7].

Malaria is usually the most common cause of fever in children under 5 years of age in stable high-transmission settings. Antimalarial treatment should therefore be given to children with fever (>37.5°C) or a history of fever and no other obvious cause. Malaria is the most likely cause of their illness and there is as yet no evidence to show that the benefits of parasitological diagnosis in this highly vulnerable group outweigh the risks of not treating false negatives. In high-transmission settings, all under-5 children with a clinical suspicion of malaria should therefore be treated [38].

In light of these recommendations, high levels of diagnostic use among under 5 year olds may not be a priority in certain countries. In such cases, the proportion of children receiving a finger or heel stick is expected to be low, and this should not be interpreted as a poorly-performing program as diagnostics may not yet be intended for wide-scale use. However, as this intervention is rolled out across countries, the indicator values reported are expected to increase.

4.4   Prevention & Control among Pregnant Women

7.   *Proportion of Pregnant Women Who Slept Under an ITN[4] the Previous Night*

- ▪ **Numerator:** Number of pregnant women who slept under an ITN the previous night.

- ▪ **Denominator:** Total number of pregnant women within surveyed households.

Purpose

This indicator will be used to measure the level of ITN use by pregnant women at the national level.

Method of Measurement

This indicator requires data collected from nationally representative household sample surveys. The MIS guidelines should be consulted for guidance on constructing a sampling frame and conducting data analyses for countries with varying levels of malaria endemicity. Because of the small number of currently pregnant women at any given time, a survey designed to collect these data should have an overall sample of ≥5,000 women (to be comparable with DHS surveys). Note that the MICS survey does not currently collect data for this indicator because it does not collect data on currently pregnant women.

The data for the denominator are obtained from a series of questions asked of all women of reproductive age in the household about their current pregnancy status. The data for the numerator are then obtained from a listing of these women that slept under a mosquito net the previous night, in combination with information on current pregnancy status and whether the net is a factory treated net that does not require any treatment, a pretreated net obtained within the past 12 months, or a net that has been soaked with insecticide within the past 12 months.

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[4] An ITN is 1) a factory treated net that does not require any treatment, 2) a pretreated net obtained within the past 12 months, or 3) a net that has been soaked with insecticide within the past 12 months.

Interpretation

This indicator provides a direct measure of ITN use by pregnant women at the national level.

Strengths	- The limited number of questions required to ascertain data for this indicator can be easily added to any nationally representative sample survey of households. - Presence of a net is typically verified at time of interview. - Comparable across countries given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for.
Limitations	- Difficult to capture all pregnant women in a household survey because many women either don't know they are pregnant or do not want to divulge this information during early pregnancy. - Large sample size required to obtain precise estimates. - May be some bias if reluctance to discuss pregnancy is also associated with first births, adolescents, and other demographic factors. - May be difficult to interpret at the national level unless stratified by urban and rural strata as malaria transmission is most often localized. - May be biased by the seasonality of survey data collection, which is most often done during the dry season when net use is likely at its lowest. - Typically, no information is collected on whether the insecticide used to treat the net is an "approved" insecticide. - No information is collected on whether the net was washed after treatment, which can reduce its effectiveness. - May be misleading at the national level as transmission is most often localized.

8.   Proportion of Women who Received Intermittent Preventive Treatment (IPT)   During Antenatal Care (ANC) Visits during Their Last Pregnancy

- ▪ **Numerator:** Number of women who received two or more doses of a recommended antimalarial drug treatment during ANC visits to prevent malaria during their last pregnancy that led to a live birth within the last 2 years.

- ▪ **Denominator:** Total number of women surveyed who delivered a live baby within the last 2 years.

Purpose

The World Health Organization recommends that all pregnant women in areas of stable malaria transmission receive at least two doses of IPT during regularly scheduled antenatal visits under direct observation of a health worker [39]. This indicator will be used to measure the national-level use of IPT to prevent malaria during pregnancy among women.

Method of Measurement

This indicator requires data collected from nationally representative household sample surveys. The MIS guidelines should be consulted for guidance on constructing a sampling frame and conducting data analyses for countries with varying levels of malaria endemicity. Additionally, because of the limited number of women who delivered a live baby within the previous 2 years, care should be taken to ensure surveys are conducted with sufficient sample size and designed to allow comparisons among regions and urban/rural strata at the individual level.

Data from the women's questionnaires for all women who delivered a live baby within the last 2 years within surveyed household is used to calculate the denominator. The numerator is derived from the number of women who mention taking an antimalarial for prevention (not treatment) during their most recent pregnancy (from among all listed births to women in the last 2 years). Note that in the DHS and MIS surveys, data from the women's questionnaire includes all births within the previous 5 years, from which the child's date of birth can be used to limit these to the last pregnancy that resulted in a live birth within the previous 2 years.

The currently recommended drug for IPT is SP. In order to obtain accurate data for this indicator, it is also important to differentiate between a treatment dose for prevention (as prescribed for IPT) and actual treatment of an existing malaria infection. Although it is extremely difficult to differentiate in the context of a survey interview, the latter is curative care, and does not count as standard IPT procedure. Similarly, women taking weekly chloroquine prophylaxis are not considered to be covered by IPT.

Interpretation

This indicator provides a measure for the proportion of pregnant women who receive IPT during pregnancy, at the national level.

Strengths	▪ The limited number of questions required to ascertain data for this indicator can be easily added to any nationally representative sample survey of households. ▪ Comparable across countries given that appropriate and consistent sampling procedures are followed and confounding factors are accounted for. ▪ Provides a measure of program coverage, as IPT is to be administered during ANC.
Limitations	▪ Retrospective questions about IPT given during previous pregnancy may be subject to recall bias. ▪ Does not provide information regarding which stage during pregnancy IPT was given. ▪ May be misleading at the national level as malaria transmission is most often localized. ▪ May not provide reliable estimates for what type of antimalarial was given because of poor recall. ▪ Household surveys may under-report the current level of IPT administered due to the fact that IPT is a relatively recent introduction in many countries and therefore women experiencing pregnancies two years prior to the survey are less likely to have had access to IPT than those women experiencing pregnancies more recently.

Supplemental Indicator

<u>HMIS as an Alternative Data Source</u>

The primary disadvantage of surveys is that their results refer to pregnancies that occurred up to two years prior to the time of the survey, and hence provide outdated estimates. However, measurement through HMIS captures IPT at the current time, and analyses can be targeted to facilities where IPT is actually being implemented. Consequently, it may be appropriate to collect data through both sources in certain cases. An IPT indicator to be obtained from ANC registers is provided in the *Global Fund M&E Toolkit* (http://www.theglobalfund.org/en/performance/monitoring_evaluation/).

This indicator provides an alternative measure of ITP delivered through ANC. It is important to note that a different denominator is used in the calculation of this indicator; consequently, direct comparisons cannot be made between this indicator and the RBM core indicator described above.

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5.   Guidelines for Constructing Each Core RBM Impact Indicator

9.   *All-Cause under 5 Mortality Rate*

Purpose/Rationale

To evaluate the impact of interventions, all-cause under 5 mortality trends should be assessed in malarious countries. In areas of stable endemicity, the major burden of malaria occurs in very young children who, because they have not yet developed adequate clinical immunity, are at highest risk of severe illness and death. Among malaria deaths in all ages, an estimated 64 to 90% occur in under 5 year olds.

Method of Measurement

The under 5 mortality rate (U5MR) can be derived from household survey data using direct or indirect methods. The direct method is used with DHS surveys and requires data collected on the birth date and either death date or age at death of non-surviving children in order to produce the probability of dying before age five from children exposed to mortality during the five year period before the survey. More specifically, the DHS employs the synthetic cohort life table approach, in which mortality probabilities for small age segments based on real cohort mortality experience are combined into larger age segments that correspond to the age group of interest. In the case of MICS surveys, under 5 mortality rates are calculated based on an indirect estimation technique known as the Brass method. This technique converts the proportion dead of children ever born reported by women in age groups 15-19, 20-24,…., 45-49 into estimates of probability of dying before attaining certain exact childhood ages. By using model life tables and strong assumptions as to age patterns and time trends, the mortality rate estimates are indirectly derived as well as the date to which they apply.

Interpretation

This indicator provides a measure of all-cause under 5 mortality, at the national level.

Strengths	- All-cause mortality can be measured reliably, and does not suffer from limitations of methods to identify malaria-specific deaths. - Is representative of large populations of interest - Captures direct and indirect malaria impacts of mortality.
Limitations	- Due to cost and other resource limitations, large nationally representative surveys are usually conducted on either three year or five year cycles, and therefore data may not be available at the optimal intervals for evaluation. - The survey recall period may not coincide exactly with the scale-up period of interventions, causing their impact to be underestimated. - Household surveys calculate mortality rates over a five-year period to make sure there are enough cases to produce reliable results. Therefore, on average, surveys measure under-five mortality with a 2-1/2 year lag. - If malaria-specific mortality decreases by 50%, a 15-19% reduction in all-cause under 5 mortality is expected; however, at the usual sample size, DHS surveys can statistically confirm under-five mortality reductions between two successive surveys if the true mortality reduction is 15% or larger. Consequently, the ability to detect a reduction in all-cause mortality resulting from fairly small reductions in malaria deaths may be difficult when relying on this data source. - Due to use of the indirect method, MICS surveys are unable to detect changes in age-patterns of child mortality.

Supplemental Impact Indicator

<u>Malaria-Specific Mortality</u>

In some cases, verbal autopsies attached to household surveys may be able to provide information on malaria-specific mortality. Verbal autopsy is a method for determining cause of death by conducting interviews with the deceased child's relatives, during which they are asked about the signs and symptoms of the child's terminal illness. Verbal autopsies can be performed either by adding questions to a mortality survey or sending interviewers after the survey to those households in which deaths were identified. This survey-linked approach provides a nationally representative measure of malaria-attributable mortality. However, operational research is needed to assess and improve these methodologies, as these methods may present challenges at the national level [7]. Therefore, it is recommended that the emphasis remains on monitoring trends in all-cause under 5 mortality at this time.

10. *Parasitemia Prevalence*

Proportion of Children Aged 6-59 Months with Malaria Infection
(To be obtained from household surveys and not from HMIS data)

- **Numerator:** Number of children aged 6-59 months with malaria infection detected by microscopy.

- **Denominator:** Total number of children aged 6-59 months tested for malaria parasites by microscopy.

Purpose/Rationale

The prevalence of parasitemia is a useful indicator of malaria burden. With intervention coverage data and repeated estimation, our understanding of the epidemiology of malaria can be improved and progress of control efforts can be tracked more effectively if estimates of parasitemia prevalence are available.

Method of Measurement

Parasitemia testing should be included in surveys that are conducted during the high transmission season for malaria. In some cases where transmission is perennial, seasonal peaks may still influence the prevalence in parasitemia and seasonality should be taken into account for planning. The MIS should ideally be conducted toward the end of the rainy season. This timeframe is associated with peak transmission and therefore is suitable for inclusion of parasitemia measurement. Large-scale household surveys are typically not suitable for inclusion of parasitemia because these surveys are not usually conducted during the high transmission season and because of the length of fieldwork, which would cover different periods of seasonal transmission.

Parasitemia testing should target children between the ages of six months and fifty-nine months. This is the same age range that is targeted for testing for anemia in both DHS and MIS surveys. Prevalence of parasitemia should be based on microscopically examined blood films prepared in the field and read in a quality-controlled laboratory by well-trained microscopists. Thick blood films will be sufficient where *P. falciparum* is dominant but where species determination is required to estimate levels of infection with *P. vivax* or other species, thin films are also warranted. While rapid diagnostic tests should be included for field detection of infected individuals, all of whom should be treated or referred according to national policy, microscopy is currently the recommended method for laboratory confirmation and estimation of parasitemia prevalence.

Microscopy and RDTs
It is important to recognize the distinction between diagnosis in clinical settings and identification of infected individuals for prevalence studies where symptoms are not taken into account. RDTs are recommended for conducting the former, but not the latter at this point in time. RDTs offer a useful alternative to microscopy in situations where reliable microscopic diagnosis is not available, as is often the case in the field. However, several issues concerning the widespread use of RDTs still remain to be addressed, including their accuracy, their cost, and their

performance under adverse field conditions. Micropscopy, too, presents special issues for survey efforts. Field teams must be adequately trained to collect specimens, mount slides, and read results. The storage and transportation of slides is also difficult in the field and requires logistical planning. Supervision of these efforts is also important. Consequently, while the use of RDTs to treat individuals in the field is encouraged, microscopy remains the standard for measuring parasitemia prevalence at the time of this publication. If the use of RDTs is recommended for estimation of population prevalence in the future, it will be important to consider how best to derive prevalence estimates and make reliable comparisons between results obtained from different methods.

Interpretation

This indicator provides a direct measure of parasitemia prevalence among children aged 6-59 months, at the national level.

Strengths	- Most malaria impact measures are indirect measures; whereas parasite prevalence is a direct, malaria-specific measure. - Parasitemia prevalence among children aged 6-59 months is a useful indicator of transmission intensity, which in turn is one of the determinants of disease incidence.
Limitations	- Some studies of malaria interventions showing mortality reductions have found large decreases in parasite prevalence; however, other studies of control interventions have found that despite reductions in mortality, parasite prevalence changes little. - Microscopy is associated with certain inherent limitations: practical difficulties of preparing and staining blood films in the field, transportation and storage issues, availability of sufficiently trained microscopists (especially in settings where speciation is required), and inconsistencies in reading slides. Despite these limitations, this is still the most reliable technology currently available, and the permanent record provided by blood films is extremely valuable.

Supplemental Indicator

Parasitemia Prevalence among Adults and Pregnant Women

It is not recommended that parasite prevalence be estimated for pregnant women on a regular basis because of the large number of households that would need to be included to obtain a sufficient sample size and because of the complexities of treating parasite-positive pregnant women in the field. However, in some cases the inclusion of all ages for testing may be warranted. These include surveys scheduled when countries are aiming for elimination, surveys that will provide for modeling of incidence of malaria, or surveys conducted when prevalence is very low. Recruitment of an older, less accessible population and treatment of pregnant women, especially early pregnancies which are more difficult to detect, should be weighed against the benefits of testing all ages. In sum, one should proceed cautiously when considering extending this indicator to respondents of all ages, but under the above circumstances special studies may be deemed appropriate and a supplemental indicator should then be calculated.

11. Anemia Prevalence

Proportion of Children Aged 6-59 Months with a Hemoglobin Measurement of < 8 g/dL

- **Numerator:** Number of children aged 6-59 months with a hemoglobin measurement of < 8 g/dL.

- **Denominator:** Total number of children aged 6-59 months who had hemoglobin measurements obtained during household survey.

Purpose/Rationale

Anemia, defined by a hemoglobin (Hb) concentration below established cut-off levels, is a widespread public health problem. It is useful to follow trends in anemia prevalence, as it is a reliable indicator of malaria morbidity that can reflect the impact of malaria interventions [34, 35]. Malaria interventions have been associated with a 60% reduction in the risk of moderate-to-severe anemia (Hb < 8 g/dL) [34].

Method of Measurement

Monitoring of anemia through household surveys has become a more viable option due to the development of the HemoCue® test of fingerprick blood, which is used to measure Hb distributions in large-scale household surveys. Anemia should be measured in children 6-59 months old. Surveys should record hemoglobin measurements to the 0.1g/dL precision level using HemoCue on capillary blood sampled while the child is sitting [35].

When classifying nutritional anemia, Hb concentrations are categorized according to criteria developed by the World Health Organization [40, 41]. The hemoglobin cut-offs that are used to classify nutritional anemia are as follows: severe anemia is diagnosed when the Hb concentration is less than 7.0 g/dL; moderate anemia when the hemoglobin concentration is 7.0 to 9.9 g/dL; and mild anemia when the Hb concentration is 10.0 to 10.9 g/dL in children. However, a different cut-off is used to classify malaria-related anemia. In this case, an Hb concentration less than 8 g/dL, which corresponds to moderate-to-severe anemia, is the cut-off level that should be used.

This indicator will measure the prevalence of Hb levels below 8g/dL, as intervention trials have shown that malaria control reduces the prevalence of moderate-to-severe anemia (e.g. below 8g/dL) more so than it reduces the prevalence of milder anemia (e.g. below 11g/dL) [34].

Interpretation

This indicator provides a proxy measure of the prevalence of malaria-related anemia among children aged 6-59 months, at the national level.

Strengths	▪ Anemia morbidity is an important health statistic to track on its own, as it is an indicator of both poor nutrition and poor health.
	▪ There is a shortage of reliable indicators that can be used to measure malaria impact in the field. Anemia provides such an indicator, as it can be measured using a standard technique due to the HemoCue technology now available.
	▪ Anemia measurement has become a standard component of DHS surveys and some other household surveys. However, it should be noted that DHS surveys include anemia measurements in the nutrition chapter, using the cut-off values listed above rather than 8 g/dL, necessitating that caution be taken when interpreting and comparing results.
Limitations	▪ A potential drawback is the seasonal variation in malaria-related anemia, which makes survey outcomes sensitive to the season of measurement.
	▪ Use of anemia as a malaria indicator in areas with low malaria transmission will inevitably be compromised by a lack of specificity, given other anemia determinants like pediatric HIV/AIDS, malnutrition, and helminth infections. Even in areas of intense malaria transmission, anemia in young children may depend more on malnutrition than on malaria, and separating malnutrition from malaria as the cause of anemia is not possible as the proportions will vary from population to population and cannot be know. Consequently, data must be interpreted cautiously, with consideration of the many other causes of anemia present in the survey area.

Supplemental Indicator

Survey reports should tabulate both the prevalence of Hb <8g/dL and the mean hemoglobin level, preferentially with its standard deviation, so that the user can derive anemia prevalences with alternative cut-offs by applying a Normal approximation [35]. In survey reports which include sections on both nutrition and malaria, the prevalence of Hb <7 g/dL and the prevalence of Hb <8g/dL should be reported in the appropriate chapters. Consequently, analyses using both Hb cut-offs will need to be conducted. Furthermore, it should be clearly stated in the text that the first is measuring severe anemia in order to assess nutritional deficiencies, while the second is measuring moderate-to-severe anemia in order to assess the impact of interventions on malaria-related anemia.

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