Impact of long-lasting insecticidal-treated nets (LLINs) and artemisinin-based combination therapies (ACTs) measured using surveillance data, in four African countries

Preliminary report based on four country visits

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Submitted by:

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Abstract

Background and methods: In collaboration with The Global Fund, the World Health Organization evaluated the impact of recent investments in malaria control by conducting field evaluations in four countries (Zambia, Ethiopia, Ghana, and Rwanda) in November-December 2007. The main interventions were nationwide distribution of long-lasting insecticidal nets (LLINs) and artemisinin-combination therapy (ACTs) medicines. The principal method was review of clinical data at rural hospitals and health centers geographically distributed in each of four countries. In Zambia, we reviewed data at the national level for all hospitals and clinics. The main impact indicator was percentage change in the number of in-patient malaria cases and deaths in children <5 years old prior to and after nationwide implementation of LLINs and ACTs. The weighted average percentage decline of in-patients in children <5 years old in in-patient facilities visited in Ethiopia was 60% for cases and 51% for deaths, and, in Rwanda, was 64% for cases and 66% for deaths. Zambia national data showed decline of 29% in cases and 33% in deaths in children <5 years old. In general, non-malaria cases and deaths remained stable or increased, except in Ghana. The median decline of in-patient malaria in Ghana was 13% for cases and 34% for deaths, but non-malaria cases and deaths declined more than those from malaria (40% and 42%).

Conclusion. We found strong initial evidence that the combination of LLINs delivered during mass distributions to all children <5 years or all households and nationwide distribution of ACTs in the public sector was associated with widespread decline of >50% in in-patient malaria and deaths throughout Rwanda and Ethiopia. The main difference between Ethiopia and Rwanda with dramatic impact, compared with Zambia and Ghana with more limited impact, was sufficient quantities of LLINs delivered in mass distributions in 2005 or 2006.

About This Report

This preliminary report is due on 31 January 2008 to the Global Fund from WHO about visits to four African countries. In the original plan devised with the Global Fund, WHO planned to visit 16 districts by the end of 2007. Because of the wishes of Ministries of Health (MOH) in Ethiopia and Rwanda, the number of health facilities visited increased from 16 to 30. In addition, national datasets from Zambia, and district datasets from two districts in Zambia by health facility became available. With the increased amount of data, it has been difficult to finish the analysis and writing in just three weeks (time available after visits were finish before Christmas and the end of the holiday season). As we more fully examine the data after 31 January 2008, we expect additional findings to emerge, but believe that the main messages will not change. For this preliminary report, we concentrated on in-patient ("hospitalized") malaria cases and deaths in children <5 years, the age group with the highest mortality rate due to malaria. As we extend our analysis, we will add more information on older age groups, out-patient cases, laboratory data, measures of dispersion, and other more in-depth analyses.

Background

Conversations, field trips, and research reports indicated impact from long-lasting insecticidal nets [LLINs] and artemisinin-based combination therapies provided by national governments and international partners, but systemic documentation was lacking. Surveys alone were not providing sufficient and timely impact data for advocacy or to optimally inform management decisions at district, national, and international levels. Therefore, the Global Fund and WHO used routine surveillance data to measure impact in several African countries. Because most countries did not have strong surveillance and logistic information systems in place, it was necessary to make field visits to districts, hospitals, and health centers to assess surveillance and logistic data. Five countries were chosen to be visited by WHO malaria personnel--Zambia, Ghana, Ethiopia, Rwanda, and Tanzania. This preliminary report covers four countries that had visits during November and December 2007.

Methods

Countries were chosen based on their early (2003-2006) introduction of LLINs and ACTs and qualitative assessment by Global Fund and WHO staff about reasonable nationwide distribution. The visits took place during November-December 2007 and lasted two weeks. A written protocol was followed by all teams for selection of districts and health facilities, and data collection. Both Ministry of Health and WHO personnel were involved in data abstraction. In Ethiopia and Rwanda, we attempted to mostly select districts with stable malaria as well as widespread geographical representation. In Zambia and Ghana, all districts have stable malaria. In each selected district, we planned for interviewers to visit one hospital and one out-patient health facility. Interviewers

abstracted data either from health-facility copies of national surveillance forms, other health information forms, or from patient registers. Data was collected from the district health team about the starting date of distribution of insecticide-treated nets (ITNs), LLINs, and ACTs in the district; and the quantity that was received by month. At least two persons visited each district for at least two days. We attempted to abstract monthly data starting in 2000. In in-patient facilities, we collected data on in-patient malaria and all-cause cases and deaths for two age groups--<5 years and ≥5 years. In out-patient facilities, we collected data on out-patient malaria and all-cause cases for two age groups (<5 years and ≥5 years) and malaria laboratory testing data where available (number of suspected malaria cases, number tested, number laboratory positive). Additional health information data was collected at the national and district level about surveillance and malaria interventions.

Selection of districts. We planned to visit 4 districts in each country and to examine national surveillance data if that was available. In Ghana, 4 districts in different parts of the country were selected based on the knowledge of reasonable malaria program operations by the national malaria program. Previous knowledge of impact measures was not used to make selections. In Zambia, we examined quarterly national health management information system (HMIS) data from 2000 to the second quarter of 2007. More than 900 health facilities report in-patient data and approximately 1300 health facilities report out-patient data. In addition, 4 districts were selected for visits that had high percentage decline in in-patient malaria cases in children <5 years old based on HMIS data. HMIS data by health facility was available, including third quarter 2007, for two of the districts visited. In Ethiopia, Ministry of Health officials wanted to expand the number of districts (weredas) from four to eight and the health facilities to 13 to cover four major Regions--Ormoya, SNNP, Amhara and Tigray (these regions have areas with

moderate and unstable malaria). Two districts (one health centre and one hospital) were selected from each Region. Selection of the districts was mainly based on knowledge of malaria burden and epidemiological risk factors (such as altitude, water bodies, etc). In Rwanda, despite the original plan to cover 4 districts, the scope of the evaluation was extended (at the request of the national malaria programme) to include all five provinces. We selected two districts randomly per province; hence covering 10 of 33 districts. We selected one hospital and one health center per district, covering 9 out of the 39 hospitals and 10 out of the 439 health centers. All heath centers had in-patient data and all out-patient departments had data on malaria laboratory testing. One health facility was excluded from analysis because of incomplete data.

Number of health facilities included in the analysis. In-patient data came from approximately 900 facilities in Zambia, 4 facilities in Ghana, 7 facilities in Ethiopia (6 hospitals and 1 health centre), and 19 facilities in Rwanda (9 hospitals, 10 health centres). Out-patient data came from approximately 1300 facilities in Zambia, 13 facilities in Ethiopia (6 hospitals, 7 health centres), and 19 facilities in Rwanda (9 hospitals, 10 health centres).

Pre-intervention and post-intervention time periods. We estimated the percentage change in malaria cases and deaths by comparing the average annual number of cases and deaths before large-scale distribution of LLINs and ACTs (usually 2000-2005) with the number of cases and deaths in the latest post-introduction period (2007). We used the same period of analysis (for example, January to October or January to November) for both baseline and post-intervention (2007) periods. The baseline period (2001-2005) was constant in Rwanda. In Ethiopia, we used different baseline periods depending on the availability of data. For in-patient data in Ethiopia, data was missing for 2001 for 3 of 7 in-patient facilities, for 2002-2003 for 2 of 7 in-patient facilities, and for 2003 for 1 or 2

of 7 in-patient facilities. Instead of imputing data, we reduced the baseline period to include years in which data was available for 6 or 7 of 7 in-patient facilities.

Impact measures. We used different impact measures depending on the type of data available. For national data from Zambia, we used total number of cases or deaths in the dataset. For Ghana, we used the median, because we purposely sampled only 4 in-patient health facilities and we did not want one hospital to over-influence our results because of size. For both Rwanda and Ethiopia, we used two types of statistical measures--weighted mean (estimate from all patient in all facilities that were visited) and median of the percentage decline among facilities. Each method had different strengths and weaknesses. The disadvantage of using the weighted mean was that large hospitals, which were more likely to have more patients and have more influence on a weighted mean. The advantage (and disadvantage) of using the median is that it would give equal weight to small rural health facilities with in-patient beds.

Impact measures and periods--Zambia. In Zambia, we used national health information data (version available in November 2007) to estimate nationwide impact. The data at the national level was data by district by quarter from 2000 to second quarter of 2007. We compared the average of first two quarters of 2000-2002 with first two quarters of 2007. The first two quarters contain the peak malaria season. In Zambia, we also used health information data by health facility by quarter from 2000 to third quarter of 2007 for two districts (Mumbwa and Katete). These data have the advantage of comparing data from the in-patient health facility that we visited with in-patient data from many health facilities in the district (>15 health facilities with in-patient beds in each case, instead of just one hospital). HMIS data from the district health team had an extra quarter (third quarter) in 2007 compared to national data.

For consistency, we excluded LLINs and ACTs delivered in 2007 because those delivered in late 2007 would not have maximal effect on cases and deaths throughout 2007.

Imputing missing data. We imputed data if there were 1-2 months missing in a year by averaging the month prior and month after the month(s) of missing data. In-patient data was imputed for 55 of 1595 health-facility-months in Rwanda, and 15 of 586 health-facility-months in Ethiopia. In-patient data was imputed for 1 of 133 facility-years in Rwanda, and no imputation of yearly data was done for Ethiopia (see *Pre-intervention and post-intervention time period* for Ethiopia).

Results

Impact. The weighted mean percentage decline for Rwanda and Ethiopia is shown in Table 1. The median percentage decline for all four countries is shown in Table 2. Note that estimates in Table 2 for Zambia were not medians but percentages of counts of cases and deaths from complete national data.

Impact--Ethiopia and Rwanda. Percentage decline of in-patient malaria cases and deaths in children <5 years old in 2007 compared to 2005 was 64% for cases and 66% for deaths in Rwanda, and 60% for cases and 51% for deaths in Ethiopia. Figure 1 and 2 show trends of in-patient malaria and non-malaria cases in children <5 years by year for Ethiopia and Rwanda. In-patient malaria cases in children decline markedly while non-malaria cases remain stable (Ethiopia) or decline only slightly (Rwanda). Figure 3 shows the decline in mean malaria slide positivity rate of 19 out-patient departments by month from 2001-2007. The median decline of all health facilities and the weighted average for all patients was >50% for all in-patient and out-patient laboratory-based indicators, except the weighted average of malaria deaths in those ≥5 years in Rwanda (13%

decline). Non-malaria in-patient cases and deaths were stable or increased for most indicators (Table 2). In-patient malaria cases and deaths in children <5 years in Rwanda declined most in health centres with small number of in-patient beds--deaths declined from an average of 36 per year to zero deaths in 2007. Both the weighted average and median percentage declines in out-patient laboratory-confirmed cases and malaria slide positivity rate in Rwanda were similar to declines in in-patient cases and deaths.

There were differences in percentage declines between health centres and hospitals in Rwanda. The percentage declines in out-patient laboratory-confirmed cases in children was >50% in 8 of 10 health centres, was >70% in 7 of 10 health centres, and was >50% in 4 of 9 hospitals. The percentage decline of in-patient malaria cases in children <5 years old was >70% in 7 of 10 health centers and >50% in 3 of 9 hospitals.

Impact--Zambia. From national data, percentage decline was 31% for in-patient malaria cases and 37% for in-patient deaths of all ages, and was 29% for cases and 33% for deaths in children <5 years. Non-malaria in-patient cases and deaths remained stable, but out-patient cases increased 48%. The median percentage decline from HMIS data for the 4 districts that were visited was 73% for in-patient malaria cases in children <5 years old and was 76% for in-patient malaria deaths in children <5 years old. In two districts that we visited that had mass distribution of LLINs in 2005 or 2006, percentage decline was 71% in cases and 33% in deaths of in-patients <5 years old in Kalomo district, and was 53% in cases and 85% in deaths in Kaoma district.

Impact--Ghana. The median percentage decline was 13% for in-patient malaria cases and 34% for in-patient malaria deaths in children <5 years old. However, non-malaria cases declined even more--40% for non-malaria in-patient cases and 42% for non-malaria in-patient deaths in children <5 years old.

Interventions. Table 3 shows available national-level information about LLIN and ACT distributions by country. Ethiopia Ministry of Health (MOH) conducted two mass distributions of LLINs--one in 2006 and one in 2005--both targeting one LLIN per 2 persons. ACTs were first distributed in the public sector in 2005. Rwanda MOH introduced LLINs and ACTs nationwide within a 2-month period (September-October 2006). The MOH conducted mass LLIN distribution to children <5 years in September 2006 during the measles campaign. ACTs were introduced quickly in October 2006 to public-sector health facilities. No nationwide mass distribution was conducted in Zambia in 2005-2006 (nationwide mass distribution was mostly completed in 2007). A nationwide mass distribution of LLINs to children <24 months was conducted in November 2006 in Ghana. There was stock-out of LLINs for routine distribution at antenatal care clinics in Ghana in the districts that we visited for nearly all of 2007.

LLIN use. Survey data indicated use of insecticide-treated nets in children <5 years old of 23% in Zambia in 2006, 55% in Ghana in 2007, and 60% in Rwanda in 2007.

Timing of decline in relation to start of interventions. The nationwide distribution in Rwanda was unique because nationwide distribution of LLINs and ACTs occurred within 60 days. The trend of cases by month indicate a clear discontinuity in November 2006 compared to September and October 2006, indicating an effect on cases within 60 days of distribution (Figure 4).

Discussion

This report documents for the first time marked, geographically widespread impact in medium- and large-sized countries using large-scale distribution of LLINs and ACTs. Our investigation showed that declines of malaria cases and deaths were dramatic in Rwanda and Ethiopia (>50%) and occurred within 12-24 months of nationwide

distribution of LLINs and ACTs. In fact, declines in in-patient cases and out-patient laboratory-confirmed cases occurred within 60 days of nationwide distribution in Rwanda (Figure 4). In both Rwanda and Ethiopia, similar declines (>50%) occurred for impact measures that required malaria laboratory testing--out-patient laboratory-confirmed cases and malaria slide positivity rate. In Rwanda, all 19 health facilities performed malaria smears on all suspected malaria cases. The decline in in-patient and out-patient laboratory-confirmed malaria cases occurred in the face of increases in out-patient and in-patient non-malaria cases in most countries during 2001 to 2004-2005 due to introduction of health insurance schemes, resolving civil conflict, and improvement of health services.

In Rwanda, there was a difference in percentage declines of in-patient cases and deaths, and out-patient laboratory-confirmed malaria cases in the 10 health centres compared to 9 hospitals. We are investigating this difference with further analyses.

In Ethiopia, indoor residual spraying (IRS) has been a well-established vector control intervention for a long period. It is applied in a focalized manner by targeting villages at risk for malaria epidemics. All districts that we visited had been applying IRS in a limited way while deploying LLINs to all populations. We were not able to evaluate contribution of IRS to the decline.

The nationwide decline in in-patient malaria cases and deaths in children in Zambia by approximately one-third is a significant achievement. However, the nationwide decline in Zambia appears to have been lower than in Rwanda and Ethiopia. The key difference between Zambia compared to Rwanda and Ethiopia appears to have been insufficient LLINs to distribute nationwide in 2005 or 2006 in Zambia. In addition, our visits to

districts and health facilities showed frequent stock-outs of ACTs occurred at health facility level in Zambia during the 2006-2007 malaria seasons. However, in contrast to the moderate impact nationally, decline of in-patient malaria cases in children in two districts with mass distribution of LLINs in 2005 or 2006 that we visited in Zambia was similar to the decline in Ethiopia and Rwanda.

The lack of definite impact associated with LLINs and ACTs in Ghana is unexplained. The decline was 13% for in-patient malaria cases and 34% for deaths in children <5 years but the declines in non-malaria cases (40% and 42%, respectively) was greater. This is consistent with general improvement in general health services, but it is difficult to confidently ascribe the moderate declines in malaria cases and deaths to the malaria interventions. The short period of data available (2005-2007) at the hospital level limited our analysis. Both malaria and non-malaria out-patient malaria cases were rising in 2005-2007, probably due to effects of health insurance in 2006 and 2007. However, it was clear that the decline in Ghana did not approach that of Rwanda, Ethiopia, or two districts in Zambia with mass LLIN distribution. Several factors may be involved in the limited impact. First, there was insufficient funding to conduct nationwide distribution of LLINs to all children <5 years or to all households. Instead, LLINs were distributed to all children <24 months in November 2006 with the limited LLINs that were available. Environmental conditions, increased rainfall, fees for public-sector ACTs, limited data to measure pre-intervention baseline, and higher malaria transmission, alone or in combination, could be responsible for the unexpected finding. Some areas of Ghana are known to have very high transmission (entomologic inoculation rate [EIR] of ~300) compared to lower levels of transmission (e.g., EIR <100) in Zambia, Rwanda, and Ethiopia. We recommended to the Ministry of Health that classic epidemiological

methods (line-listing of in-patient cases with recording of malaria intervention data on LLIN and ACT use) be used to investigate this unexpected finding during the next malaria season. The finding in Ghana raises the question whether more intensive control with LLINs and ACTs (e.g., mass distribution of one LLIN per 2 persons, elimination of health facility stock-outs and fees for ACTs, etc.) may be needed to achieve dramatic impact in areas with very high malaria transmission.

The percentage declines that we found are in line with those reported from limited areas in Kenya and Zanzibar. Okiro et al. reported that in-patient malaria cases in children in three hospitals along the Kenya coast declined an average of 57% after nationwide distribution of LLINs and ACTs in 2006.[1] In District A in Zanzibar, in-patient cases and deaths in children declined 77% and 75%, respectively, after the use of ACTs in all 13 health facilities for 24 months, prior to substantial distribution of LLINs.[2]

Our investigation had several limitations. First, in Ghana, our data was limited to four districts and availability of data was limited to 3 years duration from 2005-2007 in most in-patient health facilities that we visited. Second, we had not planned *a priori* for random selection of more health facilities in Ethiopia and Rwanda. However, the geographical spread and number of facilities that were eventually included in Ethiopia and Rwanda showed the geographical spread and consistency of impact. Third, precision of observation data is often limited by secular trends and referral bias. For example, one of the baseline years in Ethiopia could have been a year with more malaria outbreaks. These limitations were present in the data since patient load increased due to new health insurance schemes, improved services, and population in several countries. However, the effect of the combination of LLINs and ACTs was so powerful that the magnitude of

change associated with the interventions appeared to overwhelm the increase in health facility attendence. Fourth, we attributed the difference in impact between countries to quantities of LLINs and the number of ACT stock-outs but other unmeasured confounders may be partially or fully account for the differences. Finally, our sampling of health facilities was not strictly random. In addition, health facility data may not fully represent the entire district population; the magnitude of this potential bias is not known by us. However, our intention was not to produce a nationally-representative estimate of impact. This will require triangulation of several sources of data. Extending the analysis to 2008 will be important. If malaria cases and deaths remain low or decline even lower in 2008 compared to 2007, evidence for causal effect will be even stronger.

Our investigation revealed that surveillance is a powerful tool for quickly and continuously monitoring interventions with high impact at the health facility, district, and national level. In addition, the "slide positivity rate" (percentage positive out of total patients with laboratory test results) was shown to be an excellent indicator in both Ethiopia and Rwanda. The slide positivity rate declined progressively from 30-60% to near 10% and below in most health facilities in Ethiopia and Rwanda. Surveillance data was not being used as a management tool in most countries and districts that we visited, which is not unexpected since the Roll Back Malaria partnership and The Global Fund have not fully supported use of surveillance data to monitor impact, either locally or at national level, in high-burden African countries. Management information systems monitoring stock-outs at the health facility and district level were also not in place. Going forward, we believe that decentralized monitoring of surveillance and logistics data, and information systems to support analysis and use of data will be key to achieving maximal program performance and effectiveness. In addition, surveillance may become

even more important in the near future. Once use of LLINs and ACT reaches high levels, our investigation hinted that malaria may become unstable in some districts and these districts will require more timely surveillance that could detect outbreaks of malaria. We suggest that the malaria community and the Global Fund should consider the following to help countries strengthen information for promoting decentralized management: 1) establishing surveillance-based indicators (in-patient cases and deaths, out-patient laboratory-confirmed cases and malaria slide positivity rate) as the primary impact monitoring and management tool at health facility, district, and national levels. 2) encouraging countries to establish information systems to monitor stock-outs of ACT, LLINs, and rapid diagnostic tests (RDTs), 3) formulate indicators and targets in terms of percentage of districts reaching a target (for example, percentage of districts achieving >75% reduction in malaria morbidity and in-patient mortality), and 4) including surveillance and stock-out data in the Global Fund data quality audit scheme.

Although great progress has been made, much more needs to be done in the four countries to reach malaria mortality reduction levels of >75% in all districts. Many households still do not have 2 LLINs per one person and many children are not consistently sleeping under LLINs each night. The percentage of children that receive an ACT within 24 hours of onset of fever is not optimal.

In summary, this initial data indicates that widespread distribution of sufficient (at least to all children <5 years) LLINs and ACTs in the public sector resulted in widespread dramatic reductions in the burden of severe malaria morbidity and mortality. More limited impact in Zambia (nationwide) and Ghana was associated with lack of nationwide distribution of sufficient LLINs. Surveillance data revealed a potential issue with impact

in Ghana. International partners should urgently collaborate with national governments to ensure that all households have at least one LLIN per two persons, and that surveillance and logistics monitoring systems are in place in all high-burden countries to highlight management issues and enable action to resolve them. The magnitude of decline (>50%) found in Rwanda and Ethiopia is similar to that needed to reach Abuja mortality reduction targets for 2010 (>50%). It appears that dramatic reduction in malaria mortality can be achieved quickly and may enable many African countries to make rapid progress towards the child survival Millennium Development Goal.

Acknowledgements

We thanks Ministry of Health and health staff in the four countries for facilitating the field visits.

References

[1] Okiro et al. The decline of paediatric malaria admissions on the coast of Kenya, Malaria Journal 2007,6:151.

[2] Bhattarai et al. Impact of artemisinin-combination therapy and insecticide-treated nets on malaria burden in Zanzibar, PLOS, November 2007

Table 1. Percentage decline* of in-patient malaria cases and deaths and out-patient laboratory-confirmed cases in children <5 years old, 2001-2007, Rwanda and Ethiopia.

Indicator	Rwanda	Ethiopia
Comparing 2007 to 2005 as pre-intervention baseline year		
In-patient malaria cases	64	60
In-patient malaria deaths	66	51
Out-patient laboratory-confirmed cases	65	84
Comparing 2007 to multi-year pre-intervention baseline year (2001-2005 for Rwanda, 2004-2005 for Ethiopia)		
In-patient malaria cases	54	55**
In-patient malaria deaths	62	53**
Out-patient laboratory-confirmed cases	60	89

* In all health facilities that were visited

** In Ethiopia, 3 of 7 in-patient facilities had death data for only for all ages during part of 2002-2005. Therefore, we did not estimate the multi-year percentage decline in children <5 years old, but only in persons of all ages.

Table 2. Median of percentage decline in health facilities of in-patient malaria cases and deaths in persons <5 years and≥5 years, Ghana, Zambia, Ethiopia, and Rwanda, 2000-2007.

Indicator and Country		Median percentage decline in 2007 compared to pre-intervention period*	
		Malaria	Non-malaria
In-patients cases, <5 years	Ghana	13	40
	Zambia**	29	11
	Ethiopia	75	NA
	Rwanda	69	-22
In-patients cases, ≥5 years	Ghana	NA	NA
	Zambia**	33	-16
	Ethiopia	62	NA
	Rwanda	68	-72
In-patients cases, all ages	Ghana	NA	NA
	Zambia**	31	5
	Ethiopia	66	-8
	Rwanda	62	-60
In-patients deaths, <5 years	Ghana	34	42
	Zambia**	33	10
	Ethiopia	53	40
	Rwanda	97	9
In-patients deaths, ≥5 years	Ghana	NA	NA
	Zambia**	44	-2
	Ethiopia	86	20
	Rwanda	84	-3
In-patients deaths, all ages	Ghana	NA	NA
	Zambia**	37	3
	Ethiopia	77	-5
	Rwanda	87	-1
Out-patient laboratory-confirmed cases, <5 years	Ethiopia	52	NA
	Rwanda	73	NA
Out-patient laboratory-confirmed cases, ≥5 years	Ethiopia	74	NA
	Rwanda	65	NA
Out-patient laboratory-confirmed cases, all ages	Ethiopia	71	NA
	Rwanda	67	NA
Out-patient slide positivity rate, all ages	Ethiopia	72	NA
	Rwanda	78	NA

* Pre-intervention baseline period used was 2000-2002 for Zambia, 2001-2004 for Ethiopia, and 2001-2005 for Rwanda

** National data from all health facilities in Zambia, not median

Note: NA=Not available or not applicable. Negative number indicates increase

Table 3. Summary information on malaria interventions--long-lasting insecticidal nets [LLINs] and arteminsinin-combination therapy [ACTs], four African countries, 2000-2007.

Country	Ghana	Zambia	Ethiopia	Rwanda
Total population (2006 or 2007, in millions)	23.5	11.9	83.1	9.7
LLINs				
Month/year that nationwide LLIN distribution started in country	2005	2005	2005, 2006	2005
Month/year of nationwide mass LLIN distribution	November 2006, only <24 months	No nationwide mass distribution prior to 2007	Half population in 2005 and half in 2006	September 2006
Number of nets distributed in 2003-2006, national	Data not available	3.3 mil	16.6 mil	3.0 mil
Survey information about ITN household possession and use	55% ITN use in children <5 years, non-random nationwide survey, July 2007[a]	44% household ITN possession, 23% use in children <5 years, May 2006[b]	Data not yet available[c]	70% of children <5 years with LLIN in house. 60% LLIN use in children <5 years. July 2007[d]
ACTs				
Month/year that nationwide ACT distribution started in country	2005	January 2005	2005	October 2005
Number of ACTs distributed in 2004-2006, national	Not yet calculated	Data not available	10.0 mil	Data not available
Survey information about ACT use	16% of children with malaria fever in last 11 months that received drug for malaria received an ACT[a]	13% ACT use in children <5 years, May 2006[b]	Data not yet available[c]	Data not yet available[d]

[a] Mid-term assessment of malaria control programme activities in Ghana. National Malarial Control Programme, Ghana Health Service, Accra, Ghana. August 2007.
[b] Zambia Ministry of Health. Zambia National Malaria Indicator Survey 2006. Conducted May 2006.
[c] Ethiopia Malaria Indicator Survey. Conducted November 2007.
[d] Rwanda Malaria Indicator Survey. Conducted July 2007.

Figure 1. In-patient malaria and non-malaria cases in children <5 years old, January-October 2003-2007, 7 in-patient facilities, Ethiopia.

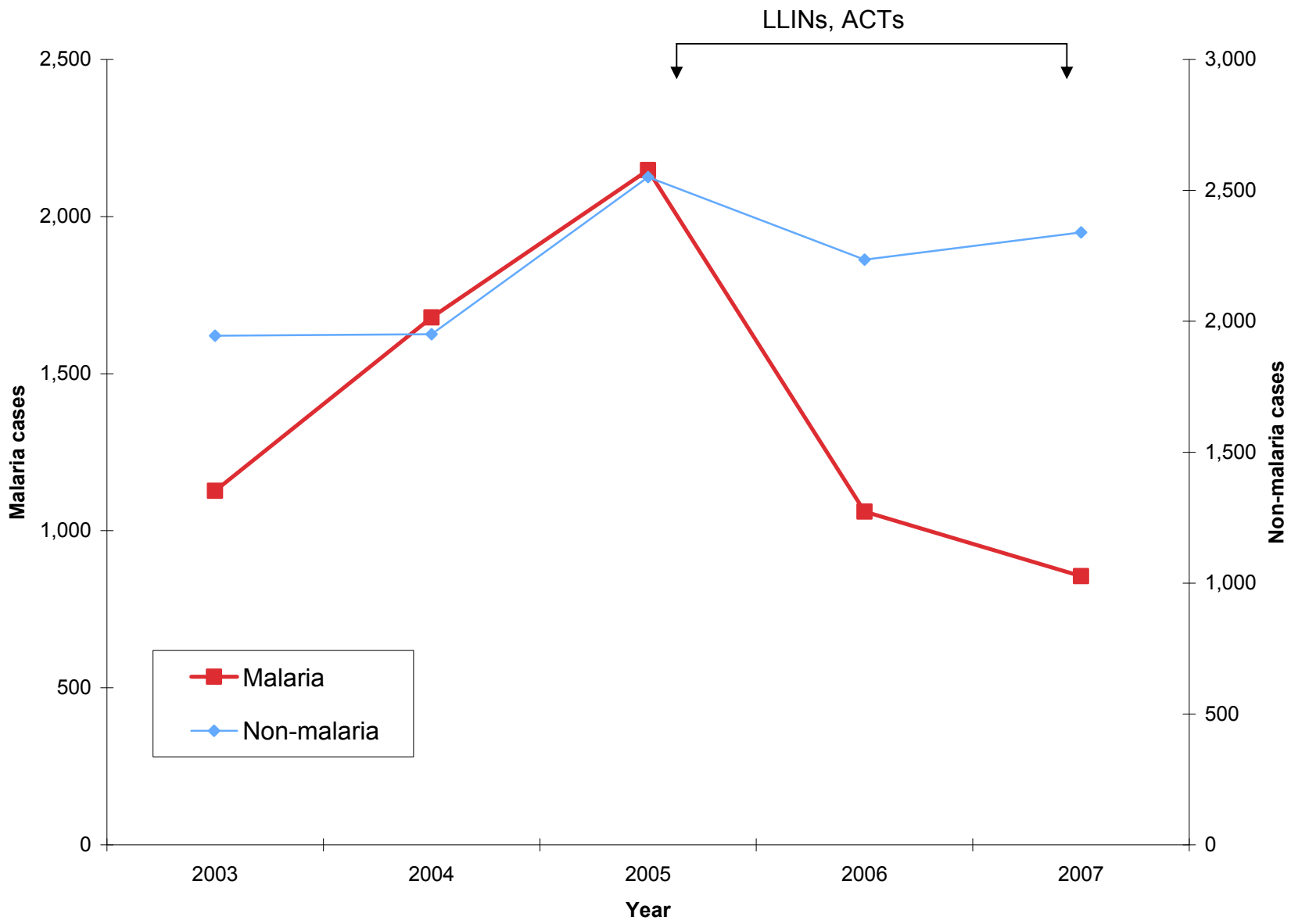

Figure 2. In-patient malaria and non-malaria cases in children <5 years old, January-November, 2001-2007, 19 in-patient facilities, Rwanda.

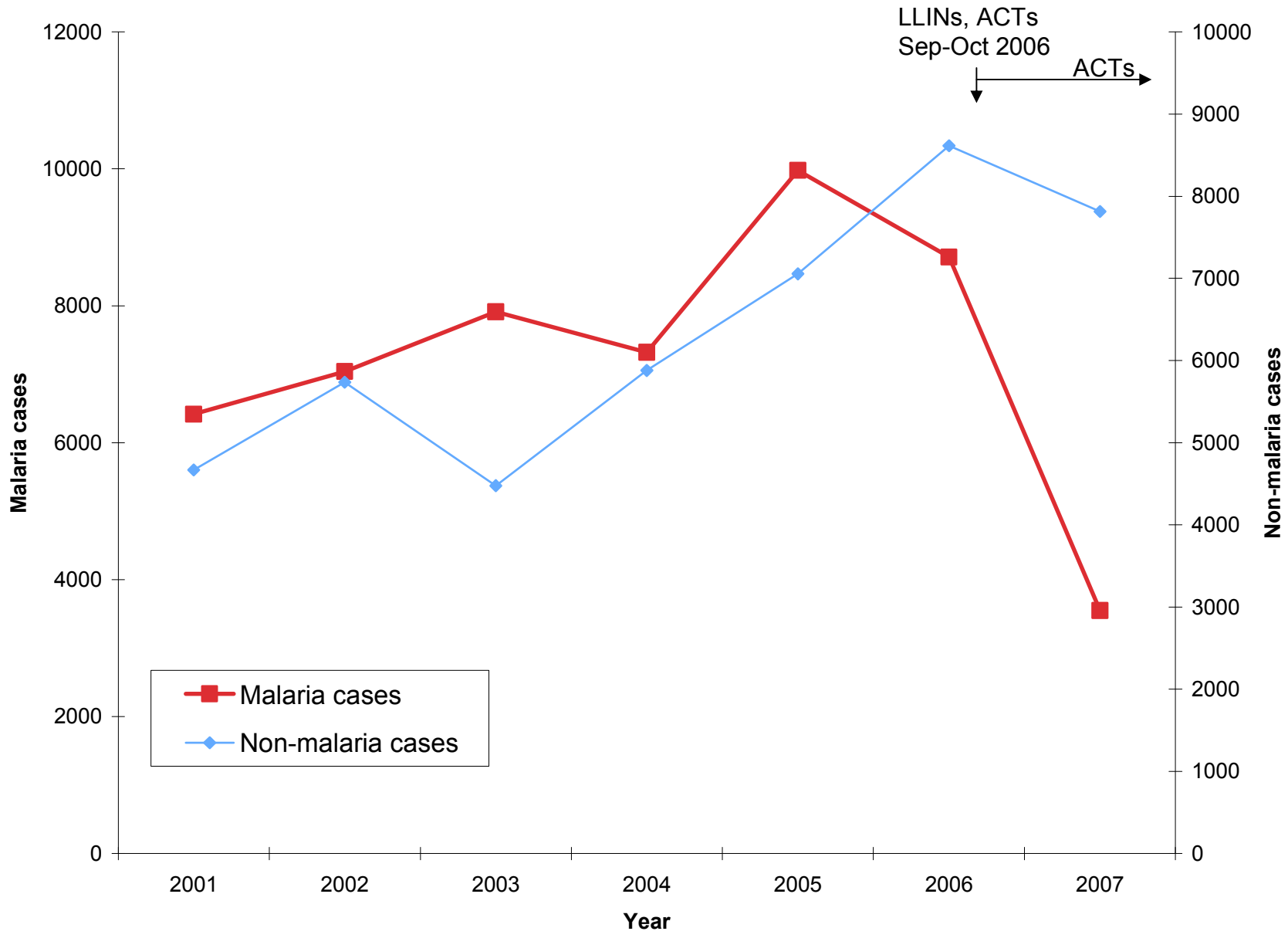

Figure 3. Mean monthly out-patient malaria "slide" positivity rate (percentage positive of those suspected malaria cases that had malaria laboratory testing), all ages, January 2001 to November 2007, 19 health facilities, Rwanda.

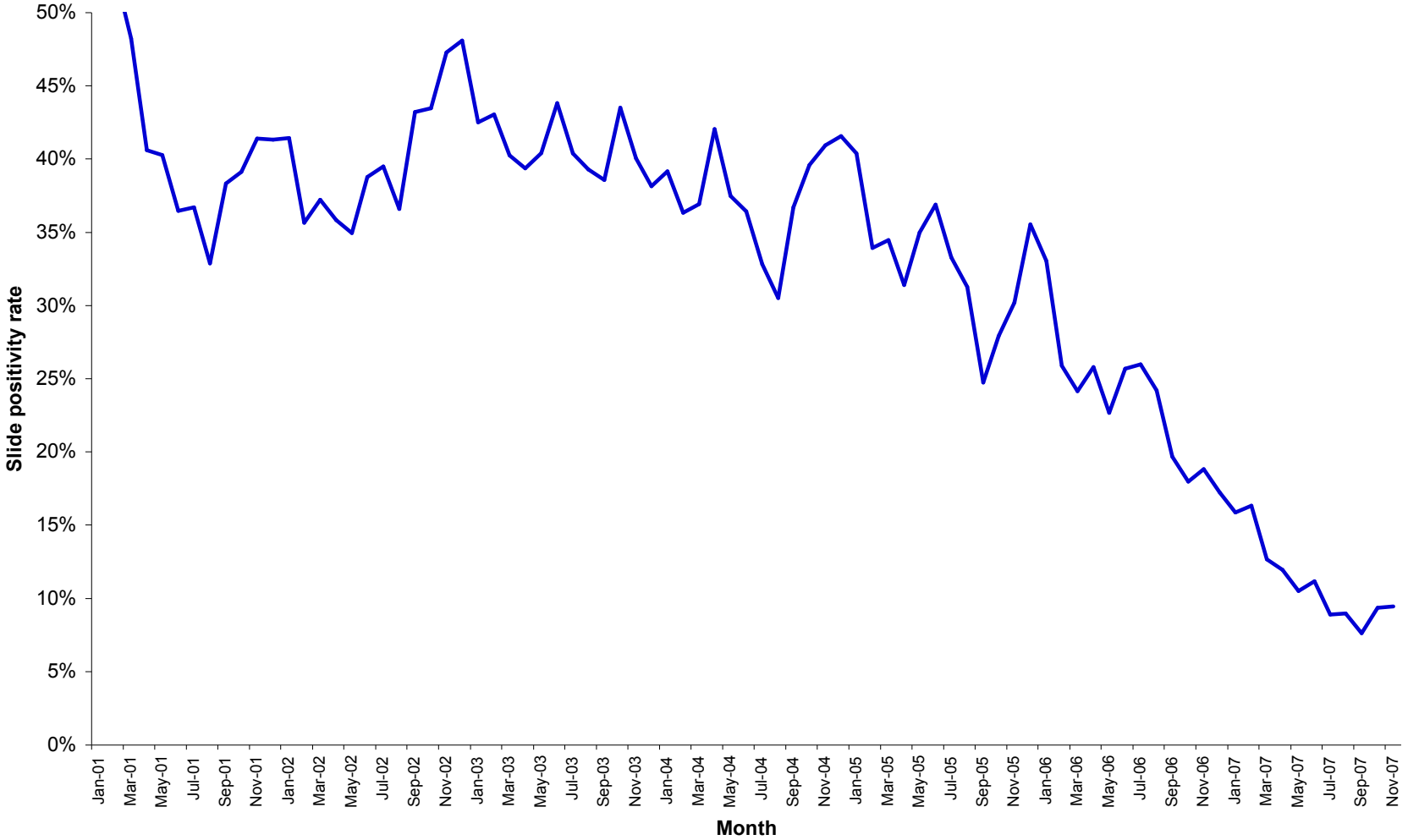

Figure 4. In-patient malaria cases, out-patient laboratory-confirmed cases, and in-patient non-malaria cases, by month,all ages, 2001-2007, Rwanda.