Evaluation of a Mobile Reporting System for the Collection of Routine Malaria Data in Mali

TR-14-107

Evaluation of a Mobile Reporting System for the Collection of Routine Malaria Data in Mali

Cristina de la Torre
Jean-Marie N'Gbichi
Kirsten Unfried

August 2014

MEASURE Evaluation is funded by the U.S. Agency for International Development (USAID) under terms of Cooperative Agreement GHA-A-00-08-00003-00 and implemented by the Carolina Population Center, University of North Carolina at Chapel Hill in partnership with Futures Group, ICF International, John Snow, Inc., Management Sciences for Health, and Tulane University. The views expressed in this publication do not necessarily reflect the views of USAID or the United States government.

TABLE OF CONTENTS

LIST OF ACRONYMS

ACT	Artemesinin-based Combination Therapy
ANC	Antenatal Care
CHW	Community Health Worker
CSCom	*Centre de santé communautaire* (Community Health Center)
DESAM	Développement Sanitaire du Mali (Database Used for the SLIS)
EEUD	Electronic Entry and Upload at the District Level
HMIS	Health Management Information System
IPT	Intermittent Preventive Treatment
ITN	Insecticide-treated Net
NMCP	National Malaria Control Program
PMI	President's Malaria Initiative
RDT	Rapid Diagnostic Test
RTA	*Rapport Trimestriel d'Activités* (Quarterly Activity Report of the SLIS)
SP	Sulfadoxine-pyrimethamine
SLIS	*Système Local d'Information Sanitaire* (Malian Health Information System)

ACKNOWLEDGEMENTS

The authors would like to thank the MEASURE Evaluation team based in Mali, specifically Jean-Marie N'Gbichi and Ignace Traore, for their assistance in reviewing the evaluation protocol and instruments, coordinating the field work for this evaluation, as well as for sharing their knowledge of how the malaria and SLIS routine reporting systems in Mali function. Their keen insights into the malaria reporting system was invaluable in planning the evaluation as well as in interpreting the findings. We are grateful to the National Malaria Control Program of Mali for helping to facilitate the evaluation, and to the staff of the various health facilities that were visited for taking the time to assist us in locating reports and registers, and for answering our questions regarding their experiences using the system. Finally, we acknowledge Yeleman, and its director Renaud Gaudin, for helping to design and create the malaria database and reporting tools, as well as for sharing information with us regarding its operation.

EXECUTIVE SUMMARY

Accurate and timely data from routine health information systems are needed in order to track malaria trends and to monitor health system performance with regards to case management and prevention efforts. This evaluation examines whether the use of improved technologies, including mobile reporting and the use of web-based databases, can help improve the timeliness, quality, and use of routine information. The evaluation used data from a routine reporting system for malaria that was recently established in Mali to examine these issues. This reporting system was designed to test two separate methods for transferring data from the facility to a central database. The first uses mobile phones to transfer data via SMS, and the second uses the internet to upload excel files to the database. Both are described in more detail below.

1. **Mobile reporting at facility (SMS)**: At the community health center, or CSCom, malaria data are extracted patient and other registers, entered onto paper forms, then entered into a cell phone program and sent via SMS directly to the web-based database, usually by the director of the clinic. Data entry and transfer to the database happens at the facility level.
2. **Electronic entry and uploading at the district level (EEUD):** Malaria data are extracted from the registers and entered onto paper forms as above. The paper forms are transferred to the district level. At the district, data are entered into an Excel spreadsheet by the health information system specialist and uploaded to the web-based database. Data entry and transfer to database happens at the district level.

In comparison, the existing health management and information system, known as the *Système Local d'Information Sanitaire* (SLIS) functions as follows:

> **SLIS reporting:** All health data for the facility, including malaria data, are extracted from patient registers and copied onto the paper form (known as the *Rapport Trimestriel d'Activités* or RTA), which is transferred to the district. At the district level, data are entered electronically into the SLIS database (DESAM). The data are aggregated for the entire district, and an electronic version of the aggregated data is sent to the region and then to the national level.

For this evaluation, a total of 935 monthly reports from 85 community health centers (CSCom) were examined to assess the timeliness, and completion of data reporting comparing the three different reporting mechanisms: SMS, EEUD and SLIS. In addition, the evaluation examined the accuracy of the data collected for the 75 CSCom that were using the newly established SMS and EEUD reporting systems to determine if accuracy varied depending on the type of reporting system used.

Data on timeliness and completeness of reporting were obtained from reports located at the district offices and by extracting information from the corresponding reporting databases. Data collectors also visited 75 CSCom that were using the SMS and EEUD reporting systems in order to assess data accuracy, and conduct a recount of malaria cases. Staff from the 75 CSCom in the SMS and EEUD areas and one representative in each of 11 selected district offices was invited to answer questions about the functionality of the reporting system they were using.

This evaluation found that SMS reporting directly from the facility was associated with significant improvements in the timeliness and completion of routine monthly reports when compared with reporting systems that rely on the transfer of paper to the district (i.e., EEUD and SLIS reporting). Virtually all SMS reports (96%) were captured in the database before the lockout date on the 10th of the month, and 85% of reports made it within 5 days of month's end.

Accuracy of the malaria data, when compared with a gold standard recount from patient registers, was very low. Fewer than 1 in 6 reports was within the acceptable ±10 percent margin of error regardless of the reporting system used (SMS or EEUD). The very large discrepancies observed between data in the database and those identified in the recount from the registers can largely be explained by the fact that community health worker data are unexpectedly being included in monthly reports by several of the CSCom. Inconsistencies between data on paper forms and those in the database were found in approximately 10% of reports. Errors in how the registers are filled out were also noted, including the absence of information on malaria testing needed to determine whether cases are confirmed. There was no statistical difference in the accuracy of data when comparing the SMS and EEUD systems.

Facility staff indicated that the SMS system was easy to use, and data entry took little time (14 minutes on average). However, issues with connectivity, including running out of air time for sending messages, were reported by about a third of users.

Mobile reporting via SMS is a practical solution in remote areas where transferring paper reports to districts in a short period of time is made difficult by poor transportation options. This technology will be especially valuable when data are time sensitive and needed shortly after data collection, for example for epidemiological surveillance or for monitoring stock-outs. However, this technology does not resolve underlying issues of data quality, and proper reporting procedures and supervision need to be continuously reinforced.

INTRODUCTION

Accurate and timely data from routine health information systems is needed in order to track malaria trends and to monitor the health system's performance with regards to case management and prevention efforts. This evaluation examines whether the use of improved technologies, including mobile reporting and the use of web-based databases, can help improve the timeliness, quality, and use of routine information. The evaluation used data from a routine reporting system for malaria that was recently established in Mali to examine these issues.

Objectives

The objective of the evaluation is to determine whether the use of a mobile reporting system increases the timeliness, completion, quality, and availability of routine data compared with a system of electronic data entry and uploading at the district level, and with the traditional Malian health information system (*Système Local d'Information Sanitaire)* (SLIS).

The information will be used to determine whether there are advantages to using mobile technology in resource-poor settings such as Mali, and whether the advantages warrant replicating and scaling up this system.

The evaluation compares three different reporting systems: 1) mobile reporting (SMS), 2) electronic data entry and upload at the district level (EEUD), and 3) the existing Malian health management information system (HMIS) (known as SLIS).

Specifically, the study will assess:

- Whether mobile reporting leads to improvements in the timeliness and completion of malaria reports compared with EEUD reporting and the Malian SLIS
- Whether data quality varies depending on whether data entry is done via mobile phone at the facility or via EEUD at the district
- Whether the new reporting system, with web-accessible reports, fosters data use at the facility and district levels

Background

In 2011, MEASURE Evaluation and the National Malaria Control Program (NMCP) in Mali, with financial support from the President's Malaria Initiative (PMI), began rolling out a new reporting system for routine malaria data. The purpose of the new reporting system is to increase the availability of malaria data in order to help monitor trends in disease burden and the impact of interventions.

In addition to expanding the type of data collected on malaria, the reporting system was designed to test two different mechanisms for reporting data to a central database: 1) via mobile reporting directly from the community health facilities, and 2) via electronic data entry and uploading at the district level.

The existing HMIS in Mali contains few malaria indicators and does not produce the information needed for strategic or programmatic decision-making. Key malaria data on testing, confirmed malaria cases, and treatment with artemesinin-based combination therapy (ACT) are lacking from the SLIS, as is information on stock outs of essential malaria drugs (e.g., ACT and sulfadoxine-pyrimethamine [SP]) and commodities (e.g., insecticide-treated nets [ITNs], and rapid diagnostic tests [RDTs]).

The SLIS is known to have problems with regards to completion, timeliness, and quality of data.[1] One of the main concerns with the SLIS, however, is that the data are largely unavailable for use because the system generates reports only annually, whereas decision-makers require more frequent access to information. Additionally, the database used by the SLIS (the Développement Sanitaire du Mali [DESAM]) is cumbersome and does not permit for the easy extraction of information for occasional or ad hoc analyses.[2]

In developing the new malaria reporting tools, MEASURE Evaluation, in partnership with PMI and the NMCP, decided to test new technological approaches to accelerate and streamline the reporting of routine malaria data. The objective is to create a system for the rapid transfer of data from lower-level facilities to make information immediately available to stakeholders and thereby facilitate decision-making based on current information.

Description of the New Malaria Reporting System

The new malaria reporting system was developed to meet the information needs of the Malian NMCP and other malaria stakeholders[3] in light of the rapid scale up of malaria prevention activities in Mali, and the need to monitor program effect on malaria morbidity and mortality. In designing the system, consideration was given to the data requirements of the NMCP and its partners, the need for timely information at all levels of the health system, and the burden of reporting on health facilities.

Indicators

Whereas the SLIS only collects data on four malaria indicators,[4] the new system is more comprehensive and collects data from health facilities on the following indicators:

- Number of suspected malaria cases
- Number and proportion of suspected cases that are tested
- Number of confirmed cases (simple and complicated malaria)
- Number and proportion of malaria cases treated with (ACT)
- Number of malaria cases that are hospitalized
- Proportion of all hospitalizations that are due malaria
- Number of deaths due to malaria
- Proportion of all deaths at the facility that are due to malaria

All these indicators are disaggregated for three separate groups: children under 5, persons aged 5 and above, and pregnant women. Additional data are collected on:

- Number and proportion of women attending antenatal care (ANC) who receive one and two doses of intermittent preventive treatment (IPT)
- Facilities reporting stock-outs of ACT, quinine, arthemether and glucose serum, SP, RDT, and ITNs
- Number of ITNs distributed to women attending ANC and to children under 5

[1] Evaluation du Système Local d'Information Sanitaire (SLIS) avec les Outils PRISM. Avril 2014. MEASURE Evaluation.
[2] For example, MEASURE Evaluation worked with SLIS staff in 2013 to try to extract data on a set of indicators and was ultimately not able to get either raw or analyzed data from the system.
[3] Including the two primary donors of malaria funds: PMI and the Global Fund to fight AIDS, Tuberculosis and Malaria
[4] Suspected malaria cases (simple and complicated), intermittent preventive treatment, and ITN distribution

Table 1: Comparison of new reporting system with SLIS

	New routine reporting system	SLIS system
Number of malaria indicators	12+	4
Frequency of reporting from facility to district	Monthly	Quarterly
Production of reports with analyzed data	Monthly	Annually
Lowest level of disaggregation	Facility	District

Reporting Mechanisms

Two separate mechanisms for reporting data to a central web-based database were established as described below. In both cases, data collection is first done at the facility level by extracting data from primary registers and then tallying and completing a paper form (Appendix A).

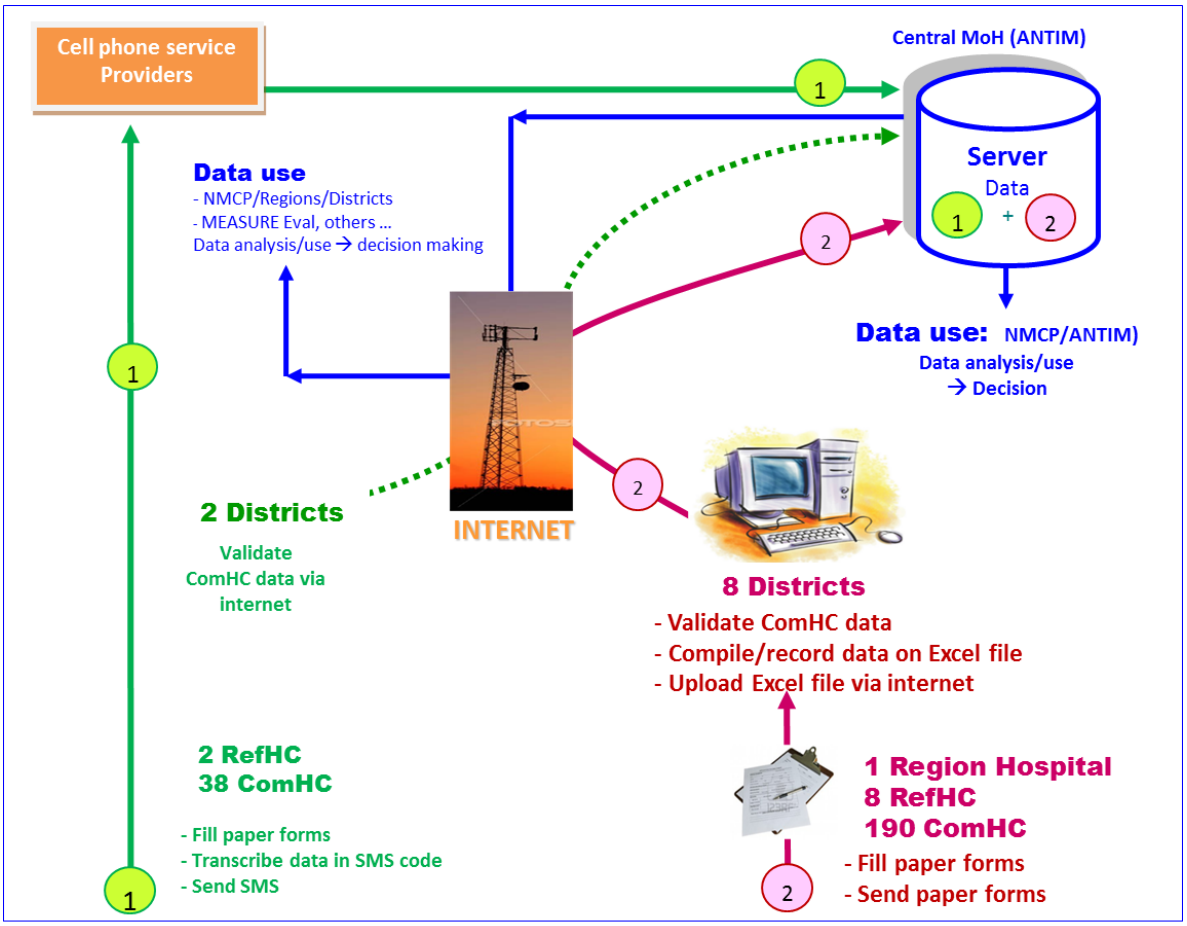
- **Mobile reporting at the facility level (SMS)**: At the community health center, or CSCom, malaria data are extracted from patient and other registers, entered onto paper forms, then entered into a cell phone program and sent via SMS directly to the web-based database, usually by the director of the clinic. The district management team receives notification that the data for a facility in their catchment area have been received, and they must validate the data online before they are released for viewing. Data entry and transfer to database happens at the facility level.
- **Electronic entry and uploading at the district level**: Malaria data are extracted from the registers and entered onto paper forms as above. The paper forms are transferred to the district level. At the district level, data are entered into an Excel spreadsheet by the health information system specialist and uploaded to the web-based database. Data entry and transfer to database happens at the district level.

Regardless of the data entry mechanism, via SMS or EEUD, the data are automatically appended to a central online database upon receipt. In either case, the district must check and validate the data before they are made public. Once validated, the automated analysis program generates reports that can be viewed by anyone with internet access and a login ID. Reports are generally available within three weeks of month's end. Reports can be disaggregated down to the facility level, and users can specify the time period and geographic area of interest.

Mobile reporting is being used in two districts of Ségou. Uploading of Excel files is used in six districts in Ségou and in two districts of Bamako.[5]

[5] Plans are underway to expand the system to the region of Mopti.

Figure 1: Data collection and transmission processes for the SMS reporting (green arrows) and EEUD reporting systems (pink arrows)



ComHC: Community Health Center RefHC: District-level Reference Health Center

Table 2: Districts using SMS and EEUD reporting systems in Mali

Region	Health district	Number of community health centers (CSCom)	SMS or EEUD reporting
Bamako	Commune 4	11	EEUD
	Commune 5	11	EEUD
Ségou	Ségou	36	EEUD
	Baraoueli	26	EEUD
	Bla	29	EEUD
	San	30	EEUD
	Tominian	20	EEUD
	Markala	19	EEUD
	Macina	18	SMS
	Niono	22	SMS

The SLIS System

Data reporting for the SLIS consists of filling in a paper form known as *Rapport Trimestriel d'Activités* (RTA) that covers all services provided at the facility level. The RTA covers a period of three months, and the paper-version is transferred quarterly to the district. At the district level, the data are entered into the DESAM database. The districts then transmit aggregated data in hard copy and electronic format (usually on flash drives) to the region. The region validates the data and transfers hard copies and electronic data to the central level. At the national level, the data are aggregated and used to produce an annual report. CSCom have 15 days after the end of the quarter to send their reports to the district. Thirty days after the end of the quarter, the districts must submit their reports to the region, and 45 days after the end of the quarter, the regions must submit reports to the central level.

METHODS

The evaluation consisted of a retrospective examination of routine malaria reports produced between June 2013 and April 2014 by health facilities across the three different intervention groups. The evaluation primarily relied on the extraction of information from monthly reporting forms, patient registers, and corresponding databases to assess reporting timeliness, completion, and data accuracy. In addition, one person charged with collecting data at each facility was selected to answer questions regarding the functionality of the reporting system.

Sampling

Sampling was designed to provide accurate estimates of timeliness and accuracy of monthly reports, and to have enough power to measure differences in these indicators across the three groups. Sample size was ultimately determined by the need to detect a 10 percentage point difference in data accuracy comparing SMS with EEUD reports. A total of 935 monthly reports were needed across the 3 groups. This number allows for 10% loss due to missing registers or other supporting documents.

Table 3: Sampling

	Number of monthly reports sampled	Number of CSCom sampled	Number of district offices sampled
SMS	330	30	2
EEUD	495	45	6
SLIS	110	10	3

Selection of CSCom

For the SMS and EEUD reporting group, CSCom were randomly selected from among all CSCom that use that reporting system. Within each group, CSCom were listed, assigned a random number, and ordered according to the random number. The top 30 and 45 CSCom in each group, respectively, were selected for the evaluation. During field work, it was discovered that one facility in the SMS group was no longer operational. This CSCom was replaced with the next facility on the ordered list.

For SLIS reporting, CSCom were randomly selected from within three districts adjacent to the mobile and EEUD districts. Due to budgetary constraints and logistical issues, it was necessary to limit the geographic coverage of the study, and it was decided to include a select number of districts adjacent to our SMS and EEUD reporting districts. The three districts were Banamba, Fana, and Koulikoro districts in the Koulikoro Region.

Data Collection Tools

Four different data collection instruments were used, with some elements borrowed from the Performance of Routine Information System Management (PRISM) tool[6]:

- Instrument for collecting data from the CSCom (for SMS and EEUD facilities)
- Instrument for collecting data from the district (for SMS and EEUD facilities)
- Instrument for extracting data from the database (for SMS and EEUD facilities)
- Instrument for collecting data from the SLIS districts

[6] PRISM Tools for Assessing, Monitoring, and Evaluating RHIS Performance. MEASURE Evaluation. http://www.cpc.unc.edu/measure/publications/ms-09-34

The tools were applied at the CSCom and district levels to examine the reports generated by the CSCom and to enquire about the functionality of the system. Additionally, data collectors were provided with a tally sheet to facilitate the recounting of cases from the primary registers.

Period of study

The evaluation examined monthly reports covering the 11-month period from June 2013 to April 2014, which corresponded to the most recent reports available at the time of the study.

Indicator Definitions

Completeness: To assess how complete malaria reporting is, the evaluation calculated the percentage of expected monthly reports that were found in their corresponding database. The number of paper forms with no missing fields was also calculated.

Timeliness: For timeliness, the evaluation looked at the proportion of reports that were entered into the database within five days of month's end, as well as the proportion of paper forms that reached the district within the deadline.

Data Accuracy: The evaluation conducted data accuracy checks on 11 months of reports, spanning June 2013 through April 2014, across 75 CSCom using the EEUD and SMS reporting systems. The data collector used a specially formulated tally sheet to recount from the patient registers all confirmed malaria cases in children under 5 for each of the months in question. These recount values were then compared with the reported number of malaria cases found in the database. Data were considered accurate if the data in the database were within ±10 % of the recount value.

The evaluation also compared data from the database with data on the paper forms located at the district offices in to determine whether errors are made during data entry. Here also, data were considered accurate if the data in the database were within ±10 % of the paper report value.

Data accuracy was not measured for SLIS facilities because the malaria indicators are not the same as for the SMS and EEUD reporting systems. More importantly, the SLIS aggregates the data in such a way when reporting up that it is not possible to access facility-specific data in the central database.

In addition to data accuracy, the evaluation examined whether the supporting materials, such as paper forms and patient registers, were available at the different facilities (CSCom and district offices) as per the reporting guidelines.

Analysis

All analyses were conducted using STATA. One data file was created that contained one observation per monthly report, and another was created that contained one observation per facility. Chi-square tests were used to assess whether there were statistical differences in each of these indicators across the three comparison groups.

RESULTS

A total of 935 monthly reports from 85 CSCom were examined to assess the timeliness and completion, of data reporting comparing the three different reporting mechanisms: SMS, EEUD and SLIS. In addition, the evaluation examined the accuracy of the data collected for the 75 CSCom that were using the newly established SMS and EEUD reporting systems to determine if accuracy varied depending on the type of reporting system used. The number of reports and facilities included in the evaluation by district is shown in Table 4. Two CSCom in the SMS group were established in 2013 and had not been added to the database at the time of the study. These two facilities were collecting malaria data on paper forms but were not able to upload data into the database, and therefore had to be excluded from the calculation of certain indicators.

Table 4: Number of facilities and reports included by region, district, and type of reporting system

		SMS		EEUD		SLIS	
Region	District	# CSCom surveyed	# monthly reports	# CSCom surveyed	# monthly reports	# CSCom surveyed	# monthly reports
Ségou	Macina	14	154				
	Niono	16	176				
	Baroueli			6	66		
	Bla			7	77		
	Markala			4	44		
	San			11	121		
	Ségou			8	88		
	Tominian			9	99		
Koulikoro	Banamba					4	44
	Fana					2	22
	Koulikoro					4	44
TOTAL	**11**	**30**	**330**	**45**	**495**	**10**	**110**

One staff member from each of the 75 CSCom in the SMS and EEUD areas[7] and 1 representative in each of the 11 selected district offices were available to answer questions about the functionality of the reporting system.

Of the 11 district-level respondents, 8 were HMIS officers (*Chargé SLIS*), 1 was a deputy HMIS officer, and 2 were point persons for malaria. Respondents at the CSCom-level were primarily (66/75) the Facility Technical Director (*Directeur Téchnique du Centre)*. The rest consisted of nurses (3), birthing attendants (2), health technicians (2), and other health staff (2). Of those interviewed at the CSCom, 83.3% had filled out the paper version of the monthly report every month in the past 6 months, 5.5% (4/72) had never filled it out, and the rest had filled it out at least once. Three respondents had a missing value for this question.

Completeness and Timeliness of Reporting

Completeness and timelines of reporting were assessed by examining the existence and timing of receipt of monthly reports in the corresponding databases (the NMCP database for the SMS and EEUD reports, and the DESAM for the SLIS reports).

[7] As noted in the methods section, the 10 CSCom using the SLIS system were not visited because data accuracy checks were not going to occur for this system. Therefore, staff from these 10 facilities were not interviewed.

The completion rate (i.e., the percentage of monthly reports found in the database) was high (90% or more) across the three groups (Table 5). The completion rate was significantly higher for SMS reports than for EEUD reports (96% versus 90%, p=0.001). The completion rate was also higher for SMS reports than for SLIS reports (96% versus 92%); however, the difference was not statistically significant (p=0.077).

While reports can be uploaded into the NMCP database up to the 10th of the month, the official deadline for entering data is on the 5th of the month. The timeliness of reporting (i.e., the percentage of reports received in the database by the 5th of the month) was significantly higher for SMS reporting than for EEUD reports (85% versus 33%, p=0.000). The SLIS database did not have a mechanism for retrospectively determining when reports were received or entered into the system, so the timeliness of reporting could not be assessed.

Table 5: Completeness and timeliness of monthly reporting

Indicator	SMS	EEUD	SLIS	Definition	
COMPLETION Percentage of reports in the database	96.1% (296/308)[1]	89.5% (443/495) (p=0.001)[2]	92% (101/110) (p=0.077)[2]	Numerator	Number of reports found in the database
				Denominator	Total number of reports expected in the database
TIMELINESS Percentage of reports received in database by the 5th of the month	84.7% (261/308)	33.3% (165/495) (p=0.000)[2]	n/a	Numerator	Number of reports received in the database by the 5th of the month deadline
				Denominator	Total number of reports expected in the database

[1] Two CSCom selected in SMS group were not yet integrated in the database. Therefore all reports for those 2 CSCom (22 reports total) were excluded from this indicator.

[2] Compared with the SMS system

For EEUD and SLIS reporting, which depend on data entry at the district level, the evaluation also examined the timing of receipt of paper reports at the district level (Table 6). The intent was to determine whether timeliness issues stemmed primarily from delays in transferring paper reports from the CSCom to the district, or from delays in data entry after the reports were received at the district. However, none of the paper versions of the reports found in EEUD district offices and only 15% of the RTA located at the district had a receipt date on the form (Table 6), making the determination of submission timeliness impossible.

Table 6: Timeliness of submission of paper reports to districts

Indicator	EEUD	SLIS	Definition	
Percentage of paper reports at the district level with receipt date stamped or inscribed	0% (0/478)	14.9% (14/94)	Numerator	Number of reports found at the district with receipt date stamped or inscribed
			Denominator	Total number of reports found at the district

Data Accuracy

To assess the accuracy of the data reported, the evaluation compared the same data points from three different sources: 1) the NMCP database, 2) the paper versions of the monthly report, and 3) recounts from the patient registers. Data accuracy was low when comparing recount values with the data in the database for the selected indicator. Only 14% and 16% of the monthly reports found in the database fell within 10 percentage point of the recount values for the SMS and EEUD systems, respectively (Table 7). For more than half of the reports, the discrepancy was greater than 50 percentage points, with the numbers reported in the database being much larger than those from the recount. There was no significant difference in data accuracy between the SMS and EEUD reporting systems (p=0.092).

The level of agreement between the data in the paper forms located at the district and those in the database was much higher. For both SMS and EEUD systems, over 90% of reports located in the database contained data that were within 10 percentage points of those appearing on the district paper forms. No statistical difference was found between SMS and EEUD reporting accuracy when comparing district forms to the database.

However, there were statistical differences in the accuracy of reporting between the SMS and EEUD systems, when we compared values in the database to those found on paper form located at the CSCom. In the EEUD facilities, 93% of the monthly reports in the database contained data that fell within 10 percentage points of those appearing in the paper forms. The percentage was significantly lower in SMS facilities, with only 78% of reports located at the CSCom falling within the 10 percentage point range.

Table 7: Accuracy of the data reported

Indicator*	SMS	EEUD	Definition	
Percentage of reports where the number of cases reported in the database are within 10 percent of the **recounted value**	14.3% (33/285)	16.1% (71/442) (p=0.092)	Numerator	Number of reports in which the value in the database is within 10 percent of the value in the registers
			Denominator	Number of instances in which there is a value in both the database and register
Percentage of reports where the number of cases reported in the database are within 10 percent of the cases reported in the paper **form located at CSCom**	77.7% (136/175)	93.2% (358/384) (p=0.000)	Numerator	Number of reports in which the value in the database is within 10 percent of the value in the paper form located at the CSCom
			Denominator	Number of instances in which there is a value in both the database and reporting form located at the CSCom
Percentage of reports where the number of cases reported in the database are within 10 percent of the cases reported in the paper **form located at district**	91.2% (104/114)	94.4% (406/430) (p=0.211)	Numerator	Number of reports in which the value in the database is within 10 percent of the value in the paper form located at the district
			Denominator	Number of instances in which there is a value in both the database and reporting form located at the district

When asked to explain why discrepancies were found in the values from the recount compared with those in the database, facility staff cited the following:

- Respondents in 28 facilities (equivalent to 308 reports) noted that there were likely errors in how registers were completed, and counting errors on the part of their staff.
- Respondents in 23 facilities (equivalent to 253 reports) indicated that the data on the paper forms and in the database include data provided by community health workers (CHWs), which are not found in the registers.
- Respondents in 9 facilities (equivalent to 99 reports) specifically mentioned that malaria test results are often not noted in the registers, making it difficult to identify confirmed cases.
- Respondents form 5 facilities (equivalent to 55 reports) noted that staff sometimes counts cases as confirmed even when the RDT is negative (because the RDT is not considered accurate).

Availability of Reports and Supporting Documents

Table 8 shows the availability of paper copies of the monthly reports and supporting registers at the CSCom and district office. For both SMS and EEUD reporting, paper copies of the monthly reports are supposed to be kept at the CSCom and at the district level.

The proportion of paper reports located at the CSCom and district levels was low for the SMS reporting system. Only 61% of the paper reports were found at the CSCom level and 41% were located at the district. For one-third (33%) of the SMS monthly reports, no paper copies were found at all (Table 8).

For the EEUD system, on the other hand, paper copies of almost all the reports were readily available at both sites (97% at the district and 84% at the CSCom), and only 2.6% of reports were missing paper copies entirely. Paper copies for 85% of the SLIS RTA reports were located at the district level and 89% of aggregated RTA reports from the district were located at the regional level. The patient registers for the corresponding months were all located at the CSCom.

Table 8: Availability of paper copies of reports and supporting registers

	Total expected reports in study	Reports found at CSCom	Reports found at district	Reports found at both CSCom and district	Reports found at neither CSCom nor district	Reports only at CSCom	Reports only at district	Reports at region	Registers available at CSCom
SMS	330	201 60.9%	136 41.2%	115 34.8%	109 33.0%	85 25.8%	21 6.4%	n/a	330 100%
EEUD	495	415 83.8%	478 96.6%	389 78.6%	13 2.6%	24 4.8%	69 13.9%	n/a	495 100%
SLIS	110	n/a[1]	94 85.4%	n/a	16 14.5%	n/a	94 85.4%	98 89.1%[2]	n/a

[1] For the SLIS, the evaluation verified the availability of reports at the district and regional level, but not at the community level.
[2] Availability information for nine SLIS reports was missing at the regional level.

Form Completeness

Approximately two-thirds of all paper reports located were complete and contained no missing fields. The notable exception was for the SMS reporting system where only 36% of reports located in the CSCom were complete. Reports located at the district level had similar completeness rates across all three groups, ranging from 64% (for SLIS reports) to 71% (for EEUD reports), with no statistical differences between the groups (Table 9).

The evaluation did not find any instances in which the paper form was missing data on the number of confirmed cases of malaria in children under 5 years, the indicator used to assess data accuracy.

Table 9: Completeness of paper forms

Indicator	SMS	EEUD	SLIS	Definition	
Percentage of forms found at the CSCom that were not missing any fields[1]	36.3% (73/201)	62.4% (259/415) (p=0.000) [2]		Numerator	Number of forms at the facility that were not missing any fields
				Denominator	Number of forms found at the CSCom
Percentage of forms found at the district that were not missing any fields[1]	68.9% (93/136)	71.0% (337/478) (p=0.644) [2]	63.8% (60/94) (p=0.424) [2]	Numerator	Number of forms at the district that were not missing any fields
				Denominator	Number of forms found at the district office

[1] Data on completeness were missing from one report in the SMS group and from three reports in the EEUD group.
[2] Compared with the SMS system

CSCOM experiences with reporting system

Data Use, Supervision, and Feedback

Most of the CSCom staff interviewed was aware that there is a website where they can review malaria reports and analyzed data, but only a few had visited the website during the previous three months (Table 10). Overall, staff from only four CSCom reported having visited the website, two each from the SMS and EEUD group. Similarly, few CSCom staff (10 out of 75) reported having received copies of an elaborated malaria report in the previous 3 months. Among CSCom staff who knew of the website's existence, the most common reasons for not having visited the website were:

- Not having a login ID (78.2%)
- Not having internet access (69.1%)
- Other reasons, including not having computer equipment (30.9%)
- Four facilities indicated they receive the information from another source (7.3%)

Supervision was low among both groups, with only six facilities out of 75 reporting having received a supervisory visit in the previous 3 months in which the quality of malaria data was discussed. However, the percentage of CSCom staff who received feedback or recommendations from the district based on malaria data was higher.

The EEUD group was significantly more likely than the SMS group to know about the website and to have received feedback from the district regarding the malaria data in the previous three months. A larger proportion of respondents in the EEUD group also reported having received a supervisory visit

and having seen a report containing malaria data in the last three months, although these differences were not statistically significant[8].

Table 10: Data use, supervision and feedback

Indicator	SMS	EEUD
Percentage of CSCom respondents who were aware that there is a website where they can review malaria reports and analyzed data	60.0% (18/30)	86.7% (39/45) (p=0.008)
Percentage of CSCom respondents who visited this website to see the analyzed data and graphics for their CSCom in the previous 3 months	11.1% (2/18)	5.1% (2/39) (p=0.411)
Percentage of CSCom who in the previous three months received a report developed with malaria data collected by the CSCom	10.0% (3/30)	15.6% (7/45) (p=0.488)
Percentage of CSCom who reported a supervisory visit in which the quality of malaria data was discussed in the previous three months	3.3% (1/30)	11.1% (5/45) (p=0.224)
Percentage of CSCom staff interviewed who received feedback, recommendations, or directives to take action from the district based on malaria data in the previous three months	53.3% (16/30)	75.6% (34/45) (p=0.046)
Percent of CSCom respondents who have held discussions around the malaria data that are collected at the facility	50.0% (15/30)	42.2% (19/45) (p=0.563)

Across both types of reporting systems (SMS and EEUD), about half of CSCom reported that they had held discussions around the malaria data collected at the facility. Among those that had discussed malaria data, almost all (94.1%) indicated that the data helped them to make decisions. The types of decisions made fell into three broad categories:

- Improving data collection
- Better tracking inventories and preventing stock-outs
- Strengthening preventive measures when caseloads increase (e.g., promoting ITN use)

Data Entry

The amount of time it took CSCom staff to enter malaria data on a cell phone each month (on average 14 minutes)is notably shorter than the amount of time it took them to complete the paper form (48 minutes on average) (Table 11). The amount of time needed to complete the paper form varied quite a bit, ranging from 5 to 240 minutes, probably as a result of varying caseloads at the different facilities.

Table 11: Duration of data collection and data entry

Indicator	
Average amount of time that it took CSCom staff (at SMS and EEUD CSCom) to complete the paper form each month (in minutes)*	48 min (range: 5–240 min)
Average amount of time that it took CSCom staff interviewed to enter malaria data via cell phone each month (in minutes)**	14 min (range: 1–30 min)

*Missing responses from three SMS CSCom and one EEUD CSCom

**Missing responses from six SMS CSCom

[8] Sample sizes for these indicators were small so it is possible that we lacked the power to detect differences.

Functionality of the Notification System

The notification system was reported to work better among CSCom staff in the SMS group compared with the EEUD group. In the SMS group, 50% of the staff interviewed reported always receiving monthly notifications of the approaching deadline for reporting their malaria data while only 14% reported this to be true in the EEUD group. Similar percentages reported sometimes receiving these notifications (36% and 38% in the SMS and EEUD groups, respectively). Only 14% reported to never receive these notifications in the SMS group, but 38% reported that they never received them in the EEUD group. There was also a notable difference between the groups in the percentage of staff who receive notifications when their report is received by the district (83% and 30% in the SMS and EEUD groups, respectively). These results should be interpreted with caution, though, because data for the first indicator were missing from roughly half of the respondents in the EEUD group.

Table 12: Notification system

Indicator		SMS	EEUD
Percentage of CSCom staff interviewed who receive monthly notifications that the deadline for data reporting malaria is approaching	Always	33% (10/30)	33% (15/45)
	Sometimes	47% (14/30)	36% (16/45)
	Never	20% (6/30)	31% (14/45)
Percentage of CSCom staff interviewed who receive notifications when their report is received by the district		47% (14/30)	31% (14/45)

Ease of Use of Reporting System

The percentage of CSCom staff that experienced specific issues with the reporting system during the previous six months was low. The most common issue reported was difficulty with cell phone connectivity, which affected the ability of 32% of CSCom staff to send data via SMS. The other most commonly reported issues were transporting paper forms to the district on time and experiencing stock-outs of paper forms. However, practically none reported difficulty with data entry on a cell phone.

Table 13: Ease of use of reporting system

Indicator	SMS	EEUD
Percentage of CSCom that reported experiencing connectivity issues that affected their ability to send data via SMS during the previous six months*	32% (8/25)	
Percentage of CSCom that reported difficulties with data entry on a cell phone during the previous six months*	4% (1/25)	
Percentage of CSCom that reported having difficulty transferring paper forms to the district on time during the previous six months	23% (7/30)	13% (6/45)
Percentage of CSCom that reported a stock-out of paper forms during the previous six months	20% (6/30)	13% (6/45)

*Missing responses from five SMS CSCom, including the two newly formed CSCom that had not been incorporated into database and therefore had no cell phones

District experiences with reporting system

Data Use and Sharing

All but one district staff interviewed had seen reports developed with malaria data for their district in the previous three months. This was also true for districts using the SLIS reporting system. Additionally, all were aware of the website where they can review reports and analyzed malaria data and had visited it in the previous three months. Among those who had visited the website, the most useful or interesting information on the website varied. Responses included case management, stock-outs, malaria prevalence, maps, and comparing CSCom and districts.

Overall, five of eight district staff had printed and shared copies of the reports containing malaria data, but only a half indicated having shared reports with the CSCom.

Table 14: Data viewing, printing and sharing

Indicator	SMS	EEUD	SLIS
Proportion of district staff interviewed who had seen reports developed with malaria data for their district in the previous three months	2/2	6/6	2/3
Proportion of district staff interviewed who were aware that there is a website where they can review the reports and analyzed malaria data	2/2	6/6	
Proportion of district staff interviewed who had visited this website to see the analyzed data and graphics for their district in the previous three months	2/2	6/6	
Proportion of district staff interviewed who had printed reports of malaria generated by the site in the previous three months	1/2	4/6	
Proportion of district staff interviewed who had shared copies of these reports of malaria with the CSCom in the previous three months	2/2	1/6	

All district staff interviewed reported receiving feedback on their malaria data from the region, but less than half reported receiving feedback from the NMCP. All staff in the SMS and control groups and half in the EEUD group reported having had district-level discussions about malaria data in the previous three months. When asked for examples of the types of decisions made, all 6 respondents mentioned discussions around stock-outs and the management of inventory.

Table 15: Feedback and discussion of malaria data

Indicator	SMS	EEUD	SLIS
Proportion of district staff interviewed who had received feedback, recommendations. or directives to take action from the region based on malaria data from their district in the previous three months	2/2	6/6	3/3
Proportion of district staff interviewed who had received feedback, recommendations, or directives to take action from the NMCP based on malaria data from their district in the previous three months	1/2	3/6	1/3
Proportion of district staff interviewed who had any discussions at the district level about malaria information they received in the previous three months	2/2	3/6	3/3

Perceptions of the Reporting Process and Workload

The amount of time it took district staff to enter all the CSCom reports into the database each month was a bit higher among the EEUD group (105 minutes versus 68 minutes), and while staff in the SMS group indicated that data entry was easy or of medium difficulty, all staff in the EEUD group reported data entry to be easy, but two staff members in the control group reported it to be difficult. The

majority of district staff found data validation and transmission to be either easy or of medium difficulty, but half of the staff in the EEUD group found data transmission to be difficult, and one staff member in the EEUD group found data validation to be difficult. About half of district staff reported having difficulties with electronic data entry in the previous six months.

Table 16: Ease of use of reporting system

Indicator		SMS	EEUD	SLIS
Average time it took district level staff interviewed each month to enter (EEUD) or validate (SMS) the monthly malaria reports for all CSCom in the database		68 min ± 74 min (range: 15–120 min)	105 min ± 90 min (range: 30–240 min)	
Proportion of district staff interviewed who said that the process of data collection was easy, medium, or difficult to undertake with this system*	Easy	1/2	5/5	1/3
	Medium	1/2	0/5	0/3
	Difficult	0/2	0/5	2/3
Proportion of district staff interviewed who said that the process of data transmission was easy, medium, or difficult to undertake with this system	Easy	1/2	3/6	2/3
	Medium	1/2	0/6	1/3
	Difficult	0/2	3/6	0/3
Proportion of district staff interviewed who said that the process of data validation was easy, medium, or difficult to undertake with this system	Easy	1/2	4/6	2/3
	Medium	1/2	1/6	1/3
	Difficult	0/2	1/6	0/3
Proportion of district staff interviewed who had difficulties with electronic data entry in the previous six months		1/2	4/6	1/3

* Missing a response from one EEUD district

DISCUSSION

Timeliness and Completeness

This evaluation found that SMS reporting directly from the facility was associated with significant improvements in the timeliness and completion of routine monthly reports when compared with reporting systems that rely on the transfer of paper to the district (i.e., EEUD and SLIS reporting). Virtually all SMS reports (96%) were captured in the database before the lockout date on the 10th of the month, and 85% of reports made it within 5 days of month's end. The EEUD system was still able to capture 90% of reports within the 10-day window, but only 33 percent of EEUD reports made it into the system within the 5-day deadline. More EEUD monthly reports on paper were found at the district than were in the database, suggesting that delays in transferring copies to the district and delays in data entry at the district may impede reports from being captured. This is not surprising given the difficulties in transferring paper to the district in areas with poor transportation and few financial resources available to facilities. Various CSCom staff noted that the transfer of paper was difficult and cumbersome, especially when it had to be done on a monthly basis. There were repeated requests by non-SMS facilities to be provided with cell phones to facilitate the transmission of data.

There was no significant difference in the completion of reporting when comparing EEUD with SLIS systems. It should be noted, however, that for SMS and EEUD reporting there is a lock-out date at the 10th of the month, after which no reports can be entered into the database. The SLIS system does not have a similar policy, and reports can be entered into the database indefinitely. Furthermore, the RTA reports used by the SLIS are quarterly reports, containing three monthly reports in one form. Thus, even if reports are entered on time in the SLIS database, the information is already somewhat dated. Unfortunately, data collectors were unable to verify the timing of report entry into the database, so the evaluation was not able to calculate (or compare) the lag between end of month and data entry for this system.

While the SMS and EEUD system were deigned to send reminders to facilities when reporting deadlines approached, only a third of respondents indicated receiving these notifications consistently. Notifications are usually made by email or by phoning the facility. It is possible that these notifications are not reaching the persons interviewed. Staff turnover could also explain the non-receipt of notifications as these tend to be sent to personal emails or cell phones.

Data Accuracy

Accuracy of the malaria data, when compared with a gold standard recount from patient registers, was very low. Fewer than 1 in 6 reports was within the acceptable ±10 percent margin of error regardless of the reporting system used (SMS or EEUD). The very large discrepancies observed between data in the database and those identified in the recount from the registers can largely be explained by the fact that CHW data are being included in monthly reports by several of the CSCom.

When the NMCP reporting system (via SMS and EEUD) was rolled out, it was not designed to include CHW data. It is not clear why some, but not all, CSCom have subsequently opted to include these data, although some comments provided by respondents indicate there may be competing guidelines and confusion generated by the parallel system established for weekly epidemiologic surveillance. It is important that clear guidelines be established regarding the inclusion of CHW data for routine health information reporting. If included in the monthly reporting system for malaria, CHW data should be disaggregated from facility data. This would facilitate not only data quality checks, but also provide

useful information regarding case management and resource allocation at different levels of the health system.

Data accuracy was also affected by counting errors and poorly filled out patient registers. In several instances, data collectors noted the absence of malaria test results in the registers with which to determine whether the case was confirmed or not. A couple of CSCom staff stated that malaria cases are sometimes reported as a confirmed case (and treated as such) even if the RDT comes back negative, due to persisting doubts as to the reliability of RDT in the field. Illegible handwriting and omitted ages were also noted by data collectors. The extent to which these issues affect reporting accuracy could not be ascertained because they were masked by the inclusion of CHW data.

Nevertheless, there is room for improvement. Increased supervision and feedback to CSCom on the quality of malaria data would be helpful. Less than 10% of CSCom indicated having received a supervisory visit within the last six months where the quality of malaria data was discussed.

Availability of Paper Forms

Many monthly reports were not available in paper format either at the CSCom or the district. The percentage of reports located at the district was highest for the EEUD group, as might be expected since paper reports for this group must reach the district before they can be uploaded to the database. For the SMS group, where only 41% of the paper reports were found at the district, it appears that the CSCom are opting not to submit paper versions, possibly assuming that the districts already have an electronic version available on the database to review.

A worrisome finding was the absence of paper versions of the reports at the CSCom level for the SMS group, combined with the fact that two-thirds of the paper reports that were found were incomplete. It appears that because the SMS CSCom erroneously feel that they are exempt from having to submit a paper report to the district, they bypass filling out paper form altogether. The importance of properly documenting the monthly reports should be emphasized with this group in particular.

The absence of paper forms may also partly be explained by stock-outs; 12 CSCom reported stock-outs of paper forms in the 6 months preceding the survey. One respondent noted that when supplies get low, duplicate copies are not kept at the CSCom. Several CSCom staff also commented that the transfer of paper forms to the district is burdensome and made difficult because of lack of resources and poor transportation options. The majority of respondents from non-SMS facilities requested changing to the mobile reporting system to facilitate the transfer of data.

Ease of Use

Overall, staff did not experience major difficulties with either system. Only 1 of 25 staff reported experiencing any difficulties with data entry on a cell phone. Data entry and data validation were considered easy by almost all respondents at the district level. However, connectivity problems were noted by about a third of SMS facilities. At the district level, where a greater number of reports need to be transmitted, three of six respondents indicated that transmission to the central database was difficult. Many of these districts rely on mobile networks (dongles) to gain internet access, and internet access is not consistent. System administrators noted that spacing the uploading of reports over two or three days at the district level, rather than trying to upload all reports right before a deadline, could help resolve issues with transmission, and would give the districts some wiggle room should they encounter temporary connectivity issues.

Data Use

At the CSCom level, approximately half of staff using the SMS and EEUD systems report having had discussions around the malaria data and having made decisions based on those data. At the district levels the numbers are higher with 8 of the 11 district staff interviewed reporting having had discussions about the malaria data in the previous 3 months. Most of the decisions cited by respondents involve managing inventory and stock-outs of RDTs and antimalarial medicines. A couple of respondents mentioned using the data for tracking fluctuations in malaria cases and strengthening prevention measures. None mentioned using the information to inform case management or clinical practices (such as improving testing rates). Working with the staff to strengthen their ability to use the data in new ways, beyond inventory management, is recommended. This will require increasing their access to elaborated reports that include analyzed data and trend analyses.

The districts using the SMS and EEUD systems have access to the web-based reports generated monthly by the system, and do visit the site to view the monthly reports. However, the CSCom rarely access the site nor do they receive feedback or printed reports based on the data they have submitted. Furthermore, 8 out of 10 CSCom staff indicated not having any login credentials to access the reports in the event that they had internet access.

None of the staff in SLIS facilities provided concrete examples of decisions made based on the malaria data. The SLIS reporting system collects only a fraction of malaria indicators as do the new SMS and EEUD systems, which may partially explain lower levels of data use.

Conclusions

Overall both the SMS and EEUD reporting systems are effective for transmitting routine data to a central server. The SMS system had better completeness and timeliness than the EEUD system, and although data entry needed to happen at the facility level, staff seemed to think this was less burdensome than having to transfer paper forms to the district level in a short window of time. The transmission of data was easier for facilities that send a single monthly report via SMS, as compared with districts that need to upload various reports at a time over an inconsistent internet connection. Staff across all facilities seems to like the mobile technology, and those who were not using SMS repeatedly requested to be included in the system.

Mobile reporting via SMS is a practical solution in remote areas where transferring paper reports to districts in a short period of time is made difficult by poor transportation options. In Mali, reports sent via SMS could easily be obtained within 5 days of the end of reporting period. However, facilities that relied on transferring paper to the district had difficulties meeting a 5-day deadline and 10% of reports were not available after the 10-day deadline. Mobile technology will be especially valuable when data are time sensitive and needed shortly after data collection, for example for epidemiological surveillance or for monitoring stock-outs. However, this technology does not resolve underlying issues of data quality, and proper reporting procedures and supervision need to be continuously reinforced regardless of the type of reporting system used.

Some limitations of the SMS system appear to be less supervision and less feedback from districts to CSCom using SMS compared with those using EEUD. Perhaps receiving the paper report and having to enter the data encourages the district to review and discuss the data (including possible errors) with the CSCom. Reinforcing supervision and data quality checks for all systems would help improve these issues.

The system sought to make data more readily available for decision-making by providing internet access to monthly reports that contain analyzed data, graphs and maps. While the districts do access the website and indicate using the data, the information is not making its way down to the CSCom level. The use of smart phones might be explored as a means of accessing the elaborated malaria reports and promote data use at the lower levels of the health system.

APPENDIX A: PAPER REPORTING FORM USED AT FACILITY LEVEL

Formulaire de Collecte de données - Données sur l'Information de Routine du PNLP - Niveau District Sanitaire (Csréf/Cscom)

Région Médicale			
District Sanitaire		Mois	Année
Etablissement sanitaire			

Classification	Consultation		
	< 5 ans	**5 ans et plus**	**Femmes enceintes**
Total consultation, toutes causes confondues			
Nbre de Cas de paludisme (Tous suspectés)			
Cas de paludisme testés (GE et/ou TDR)			
Cas de paludisme confirmés (GE et/ou TDR)			
Nbre de Cas de paludisme Simple			
Nbre de Cas de paludisme Grave			
Nbre de Cas traités avec CTA			

Rupture de stock CTA pendant le mois (Oui, Non)	
CTA Nourrisson - Enfant	
CTA Adolescent	
CTA Adulte	

PEC de cas de Paludisme grave Rupture de stock OUI/NON	
Arthemether injectable	
Quinine Injectable	
Serum Glucosé 10%	

Classification	Hospitalisations		
	< 5 ans	+ 5 ans	Femmes enceintes
Total Hospitalisés Paludisme			
Total Hospitalisations toutes causes confondues			

Rupture de stock pendant le mois O/N (Oui, Non)	
MILD	
TDR	
SP	

Classification	Décès		
	< 5 ans	5 ans et plus	Femmes enceintes
Cas de décès pour paludisme			
Total cas de décès toutes causes confondues			

CPN/SP des femmes enceintes (nbre)	
CPN	
SP 1	
SP 2	

Moustiquaires imprégnées d'insecticide distribuées		
Classification	< 5 ans	**Femmes enceintes**
Nombre de moustiquaires distribuées		

Nom et Prénom : _____

Le Responsable CSCom/CSRéf

Date : _____/20___