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## Effect of the Ebola-virus-disease epidemic on malaria case management in Guinea, 2014: a cross-sectional survey of health facilities

Mateusz M Plucinski, Timothée Guilavogui, Sidibe Sidikiba, Nouman Diakité, Souleymane Diakité, Mohamed Dioubaté, Ibrahima Bah, Ian Hennessee, Jessica K Butts, Eric S Halsey, Peter D McElroy, S Patrick Kachur, Jamila Aboulhab, Richard James, and Moussa Keita  
Malaria Branch, Centers for Disease Control and Prevention, Atlanta, GA, USA (M M Plucinski PhD, J K Butts MPH, E S Halsey MD, P D McElroy PhD, S P Kachur MD, J Aboulhab MD); President's Malaria Initiative, Atlanta, GA, USA (M M Plucinski, J K Butts, E S Halsey, P D McElroy, J Aboulhab); National Malaria Control Programme, Ministry of Health, Conakry, Guinea (T Guilavogui MD, N Diakité MD, S Diakité MD, M Dioubaté MS, M Keita MD); Mafèrinyah Rural Health Research Center, Mafèrinyah, Guinea (S Sidikiba MD); Catholic Relief Services, Conakry, Guinea (I Bah MS); Rollins School of Public Health, Emory University, Atlanta, GA, USA (I Hennessee MPH); and Division of Prevention and Disease Control, Ministry of Health, Conakry, Guinea (R James MD)

### Summary

**Background**—The ongoing west Africa Ebola-virus-disease epidemic has disrupted the entire health-care system in affected countries. Because of the overlap of symptoms of Ebola virus disease and malaria, the care delivery of malaria is particularly sensitive to the indirect effects of the current Ebola-virus-disease epidemic. We therefore characterise malaria case management in the context of the Ebola-virus-disease epidemic and document the effect of the Ebola-virus-disease epidemic on malaria case management.

**Methods**—We did a cross-sectional survey of public health facilities in Guinea in December, 2014. We selected the four prefectures most affected by Ebola virus disease and selected four randomly from prefectures without any reported cases of the disease. 60 health facilities were sampled in Ebola-affected and 60 in Ebola-unaffected prefectures. Study teams abstracted malaria case management indicators from registers for January to November for 2013 and 2014 and interviewed health-care workers. Nationwide weekly surveillance data for suspect malaria cases reported between 2011 and 2014 were analysed independently. Data for malaria indicators in 2014 were compared with previous years.

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Correspondence to: Dr Mateusz M Plucinski, Malaria Branch, Centers for Disease Control and Prevention, 1600 Clifton Road, Atlanta, GA 30329, USA, mplucinski@cdc.gov.

#### Contributors

MMP, TG, SS, ND, SD, MD, JKB, RJ, and MK designed the study. SS, ND, SD, MD, IB, and RJ gathered the data. MMP, TG, SS, ND, SD, MD, IH, JKB, ESH, PDM, SPK, and JA analysed and interpreted the data. MMP, TG, SS, ESH, SPK, and JA wrote the manuscript.

#### Declaration of interests

We declare no competing interests.

**Findings**—We noted substantial reductions in all-cause outpatient visits (by 23 103 [11%] of 214 899), cases of fever (by 20249 [15%] of 131 330), and patients treated with oral (by 22 655 [24%] of 94 785) and injectable (by 5219 [30%] of 17 684) antimalarial drugs in surveyed health facilities. In Ebola-affected prefectures, 73 of 98 interviewed community health workers were operational (74%, 95% CI 65–83) and 35 of 73 were actively treating malaria cases (48%, 36–60) compared with 106 of 112 (95%, 89–98) and 102 of 106 (96%, 91–99), respectively, in Ebola-unaffected prefectures. Nationwide, the Ebola-virus-disease epidemic was estimated to have resulted in 74 000 (71 000–77 000) fewer malaria cases seen at health facilities in 2014.

**Interpretation**—The reduction in the delivery of malaria care because of the Ebola-virus-disease epidemic threatens malaria control in Guinea. Untreated and inappropriately treated malaria cases lead to excess malaria mortality and more fever cases in the community, impeding the Ebola-virus-disease response.

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## Introduction

The Ebola-virus-disease epidemic in Guinea showed three successive waves of transmission during the whole of 2014. Although the first two waves were attributable to localised transmission in Conakry and some prefectures in forested Guinea,<sup>1</sup> the third, most intense wave indicated transmission throughout Guinea.

Although the Ebola-virus-disease epidemic caused an estimated 9976 deaths as of March 8, 2015, of which 2170 were in Guinea,<sup>2</sup> the indirect effects of the epidemic<sup>3,4</sup> might ultimately cause more morbidity and mortality than Ebola virus disease.<sup>5</sup> The effect of the Ebola-virus-disease epidemic on the health-care system in affected countries might adversely affect health-seeking behaviour and thus the delivery of life-saving care to patients, as reported for the severe acute respiratory syndrome (SARS) epidemic.<sup>6</sup> This effect is particularly relevant to malaria control efforts<sup>7</sup> because of an overlap of symptoms for malaria and Ebola virus disease and the dependence of malaria-control efforts on case management delivered at, or coordinated through, health facilities.

Guinea is highly endemic for malaria, with infection prevalence in children younger than 5 years old of 44% in a 2012 survey.<sup>8</sup> Malaria is the main cause of visits to health facilities in Guinea, accounting for more than 30% of visits to public health facilities.<sup>9</sup> An important part of the National Malaria Control Programme’s activities is the expansion of access to malaria diagnostics, most commonly rapid diagnostic tests, and antimalarial treatments in the form of artemisinin-based combination therapy for simple malaria and parenteral treatment with artemisinin derivatives for severe malaria. Access to artemisinin-based combination therapy and rapid diagnostic tests is provided through public health facilities and a network of more than 3000 community health workers, each supplied and supervised from a health centre.

Coinciding with the start of the third wave of the Ebola-virus-disease epidemic in Guinea, the National Malaria Control Programme began receiving widespread reports of falling

attendance at health facilities throughout the country and there was a large-scale collapse of the community malaria case management programme. The National Malaria Control Programme commissioned a nationwide survey of health facilities, complemented by an analysis of surveillance data available nationally, to verify and quantify these anecdotal reports, to characterise malaria case management in the context of the Ebola-virus-disease epidemic, and to document the effect of the Ebola-virus-disease epidemic on malaria case management.

## Methods

### Study design

We did a cross-sectional survey of 120 public health facilities in eight prefectures (appendix), including the four prefectures most affected by Ebola virus disease as of mid November, 2014, and another four prefectures selected randomly, stratified by region, from prefectures with no reported cases of Ebola virus disease as of mid November, 2014. 15 health facilities were selected in each prefecture from a list of all public health facilities using a computer-generated random sequence. Sampling was stratified by the type of health facilities, with one hospital, seven health centres, and seven health posts (the most basic structure for health facilities) sampled per prefecture. At each hospital, data gathering and interviews were done separately for the general medicine and paediatric wards. The Guinea Ministry of Health reviewed the activity and classified it as programme evaluation.

Sampled health facilities were visited by one of eight study teams throughout December, 2014. If a health facility was permanently closed, the reason for closure was recorded. Otherwise, study teams abstracted data from registers using standardised forms for data gathering and interviewed at least one health-care worker (the health-care worker most familiar with malaria case management practices in the health facility) and up to five community health workers randomly chosen by systematic sampling from a list of community health workers (for health centres only) using standardised questionnaires. For data abstraction from registers, study teams located registers for Jan 1, to Nov 30, 2013, and Jan 1, to Nov 30, 2014. For each month, study teams counted the number of all-cause outpatient visits, fever cases, malaria diagnostic tests done, confirmed malaria cases, and patients treated with oral and injectable antimalarial drugs, separately for children younger than 5 years and for children aged 5 years and older and adults. Similarly, study teams abstracted the number of antenatal visits and number of pregnant women given sulfadoxine-pyrimethamine for intermittent preventive malaria treatment. For registers from Nov 1–30, 2013, to Nov 1–30, 2014, study teams randomly selected 40 visits by patients, and recorded age, presence of fever, and whether the patient was tested or treated, or both, for malaria.

Selected health-care workers and community health workers were asked about malaria case management practices before and after the Ebola epidemic, specifically use of rapid diagnostic tests and artemisinin-based combination therapy and perceived changes in attendance at health facilities. Workers reporting decreases in attendance were asked to provide possible explanations.

## Statistical analysis

The proportion of operational health facilities was calculated, with stratification by Ebola-unaffected and Ebola-affected prefectures. Monthly numbers of all-cause outpatient visits, fever cases, and patients treated with oral and injectable antimalarial drugs were plotted for January to November for 2013 and 2014, and the percentage change was calculated. The percentage change for each indicator abstracted from registries was calculated separately for January to March, April to July, and August to November, corresponding to the three waves of the Ebola-virus-disease epidemic in Guinea in 2014 (Jan 1 to March 31, April 1 to July 31, and Aug 1 to Nov 30). The percentage change was calculated separately for children younger and older than 5 years and for adults, with stratification by Ebola-unaffected and Ebola-affected prefectures.

From the registry abstraction of visits by individual patients for Nov 1–30, 2013, and Nov 1–30, 2014, proportions of fever cases tested for malaria with rapid diagnostic testing and microscopy, presumptively treated for malaria (without any malaria test result recorded), with positive laboratory malaria tests treated with antimalarial drugs, and with negative laboratory malaria tests treated with antimalarial drugs were calculated separately for Ebola-unaffected and Ebola-affected prefectures. With a difference-in-differences regression analysis, indicators from November, 2013, and November, 2014, were compared within each prefecture, and subsequently the change from November, 2013, to November, 2014, in the Ebola-unaffected prefectures was compared with the change in the Ebola-affected prefectures, with the p value calculated from the interaction term of year and prefecture (unaffected or affected) in the regression analysis. To account for sampling strategy and clustering of observations from health facilities, regression analyses were done and proportions were calculated with the R survey package (version 3.29),<sup>10</sup> calculating the selection probability as the product of the probability of the health facilities being chosen multiplied by the fraction of patients' records abstracted for the detailed registry review.

Community health workers' self-reported use of rapid diagnostic tests and artemisinin-based combination therapy, wearing of gloves, and referral of fever cases to health facilities before and after the Ebola-virus-disease epidemic were analysed in Ebola-unaffected and Ebola-affected prefectures. The change in these self-reported practices from before to after the start of the Ebola-virus-disease epidemic was compared between Ebola-unaffected and Ebola-affected prefectures with difference-in-differences regression analyses. The proportion of health-care workers and community health workers reporting increases and decreases in attendance in health facilities was calculated.

Data for nationwide weekly cases of malaria, aggregated at the prefecture level, were obtained from the Guinea Ministry of Health's Division of Prevention and Disease Control. Modelled on WHO's Integrated Disease Surveillance and Response system,<sup>11</sup> the surveillance system gathers data for ten diseases on a weekly basis from public health facilities by telephone. The weekly surveillance system does not capture data from all health facilities, and generally does not include data from health posts and community health workers. The weekly number of suspect malaria cases was plotted for January, 2011, to December, 2014. A Poisson regression model was fit to the weekly suspect malaria data per prefecture stratified by highly affected (reporting > 250 cumulative cases of Ebola virus

disease by November, 2014), less affected (reporting <250 cumulative cases), and unaffected prefectures (no reported cases), and before and after the start of the third wave of the epidemic. To adjust for geographical and seasonal variation, the model included prefecture, month, and interaction terms. G-computation<sup>12</sup> was used to estimate the decrease, with 95% CIs, in suspect malaria cases reported by the weekly surveillance system as a result of the Ebola-virus-disease epidemic.

### Role of the funding source

The funder had no role in the study design, data gathering, analysis, interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

## Results

Of the 60 sampled health facilities in Ebola-unaffected prefectures, two health facilities (3%), both of which were health posts, were permanently closed (table 1) because there were no health-care staff, for reasons unrelated to the Ebola-virus-disease epidemic. Of the 60 sampled health facilities in the Ebola-affected prefectures, five health facilities (8%) were closed, including one hospital, one health centre, and three health posts. All closures were related to the Ebola-virus-disease epidemic, with reasons ranging from deaths of medical staff from Ebola virus disease to community resistance (appendix). In open facilities, 125 health-care workers and 219 community health workers were interviewed.

In operational health facilities, data from registry abstraction showed consistent decreases in attendance (by 23 103 [11%] of 214 899), cases of fever (by 20 249 [15%] of 131 330), and patients treated with oral antimalarial drugs (by 22 655 [24%] of 94 785), and injectable antimalarial drugs (by 5219 [30%] of 17 684) in 2014 compared with 2013 (figure 1). Generally, the reductions were first noted in Ebola-affected prefectures during the second wave (April to July) of the epidemic, then in Ebola-unaffected prefectures during the third wave (August to November) of the epidemic (table 2; appendix). The reductions increased over time, with the largest reductions occurring during the third wave of the epidemic (table 2; appendix). The reductions were largest for patients treated with injectable antimalarial drugs, followed by patients treated with oral antimalarial drugs, cases of fever, and all-cause outpatient visits in adults and children aged 5 years and older in Ebola-affected prefectures (table 2; appendix). The reductions were more marked in adults and children aged 5 years and older than in children younger than 5 years old. Although antenatal visits fell during the third wave of the epidemic in Ebola-affected prefectures, the number of sulfadoxine-pyrimethamine doses administered to pregnant women attending an antenatal clinic was greater in 2014 than in 2013 in all prefectures (table 2; appendix).

Analysis of individual visits by patients recorded in November, 2013, and November, 2014, showed changes in malaria case management practices at health facilities (table 3). Although the proportion of cases with fever tested for malaria increased in Ebola-unaffected prefectures from 37% in November, 2013, to 65% in November, 2014, it did not change significantly in Ebola-affected areas, falling slightly from 47% in November, 2013, to 45% in November, 2014 (table 3). Test positivity decreased in Ebola-unaffected prefectures,

while it stayed the same in Ebola-affected prefectures (table 3). The rate of presumptive treatment of fever cases stayed the same in Ebola-unaffected prefectures, but decreased from 32% to 23% in Ebola-affected areas (table 3). Overall, the proportion of cases of fever treated with antimalarial drugs at health facilities was not substantially different between 2013 and 2014 in Ebola-unaffected prefectures, but decreased from 62% in 2013 to 54% in 2014 in Ebola-affected prefectures (table 3).

In Ebola-unaffected prefectures, 42 (69%) of 61 health-care workers reported decreases in attendance at health facilities compared with 59 (97%) of 61 in Ebola-affected areas. The most common explanations provided by health-care workers and community health workers for the decreases were patients' fears of health-care workers (138 [55%] of 251), contracting Ebola virus disease during a visit to a health facility (93 [37%] of 251), and being sent to an Ebola treatment centre (64 [25%] of 251).

Community health workers also reported changes in practices in malaria case management. Although the proportion of community health workers in Ebola-unaffected prefectures who reported being active increased from 78% before the Ebola-virus-disease epidemic to 95% since the start of the Ebola-virus-disease epidemic, this trend was reversed in affected prefectures, falling from 98% to 74% (table 4). Among active community health workers, the proportion doing malaria case management increased from 63% to 96% in Ebola-unaffected prefectures, but fell from 68% to 48% in Ebola-affected prefectures (table 4). Although 95% of operational community health workers reported using rapid diagnostic tests in Ebola-unaffected prefectures in 2014, up from 60% since before the Ebola-virus-disease epidemic, only 30% of operational community health workers reported using rapid diagnostic tests in Ebola-affected prefectures, down from 70% before the Ebola-virus-disease epidemic (table 4). This drop in the use of rapid diagnostic tests was not outweighed by a corresponding increase in reported presumptive treatment with artemisinin-based combination therapy, at 9% before the start of the Ebola-virus-disease epidemic and 11% afterwards (table 4).

Nationwide, although the weekly total number of suspect malaria cases was lower in 2014 than in previous years at the start of the year, there was a typical peak during June and July, 2014 (figure 2). However, there was a rapid fall in the number of reported cases, starting near the end of August, mirroring the results from the health facility survey.

In 2014, before the third wave of the epidemic, weekly suspect malaria cases in less-affected prefectures were not significantly different from expected, but were 22% (95% CI 22–23) lower than expected in prefectures highly affected by the Ebola-virus-disease epidemic. Since the start of the third wave of the epidemic in August, 2014, weekly malaria cases were 8% (6–9) lower than expected in unaffected prefectures, 14% (11–15) lower than expected in less affected prefectures, and 42% (40–43) lower than expected in highly affected prefectures.

For all of Guinea for 2014, the Ebola-virus-disease epidemic is estimated to have resulted in a reduction of 74 000 suspect malaria cases (95% CI 71 000–77 000) seen at public health facilities as reported through the weekly surveillance system.



## Discussion

The results of the data gathering in health facilities, confirmed through weekly surveillance data, indicate a substantial decline in all-cause outpatient visits, fever cases, and number of patients treated with antimalarial drugs at public health facilities in Guinea, coinciding with the worsening of the Ebola-virus-disease epidemic in August, 2014. This decrease occurred throughout the country, even in areas with no reported cases of Ebola virus disease. The decrease occurred despite health facilities generally remaining open, likely because of financial incentives put in place by the National Ebola Coordination to encourage health-care workers to remain at health facilities. Although community members were not interviewed during this survey, data from interviews of the health-care workers and community health workers support the hypothesis that the decline in attendance is likely indicative of the population's fear of accessing the formal health sector.

The decline in the number of patients receiving antimalarial drugs is only partly explained by reduced attendance at health facilities, pointing to subtle changes in health-care seeking and delivery that differ significantly between Ebola-affected and Ebola-unaffected areas. Since the start of the Ebola-virus-disease epidemic, patients have been less likely to seek care at health facilities or report fever. The interpretation of testing and treatment rates at health facilities is not straightforward because the Ebola-virus-disease epidemic coincided with a scale-up of rapid diagnostic test, artemisinin-based combination therapy, and sulfadoxine-pyrimethamine training and distribution to health facilities, confounding the effect of the Ebola-virus-disease epidemic on testing and treatment. However, even with the scale-up of the availability of rapid diagnostic tests, rates of testing did not increase in Ebola-affected prefectures. Contrary to expectation, the rate of presumptive treatment of fever cases with antimalarial drugs in health facilities and by community health workers decreased or did not change since the start of the Ebola-virus-disease epidemic.

To address concerns about Ebola virus transmission during malaria testing, WHO released guidelines for malaria case management in Ebola-affected zones in November, 2014.<sup>11</sup> The guidelines include the suspension of malaria testing by community health workers and in health facilities without appropriate protective equipment. In these settings, presumptive treatment of fever cases should be implemented. The Guinea National Malaria Control Programme adopted these recommendations in December, 2014, after the completion of the study reported here. The dissemination of the new guidelines and retraining of health-care workers and community health workers is ongoing.

The timing of the reduction in the number of malaria cases seen and treated in health facilities, larger reduction in areas more affected by Ebola virus disease, more pronounced reduction in adults and older children (age groups at higher risk of contracting Ebola virus disease than were younger children), and data gathered from interviews with health-care workers and community health workers, all lend support to the hypothesis that the reduction is attributable to the Ebola-virus-disease epidemic in Guinea. Several key alternative explanations for the reduction can be excluded. Climatic changes are unlikely to have caused the decline, since 2014 was an average year for rainfall in Guinea (appendix). Although there were universal campaigns for coverage of bednet distribution throughout

Guinea in late 2013, and early 2014, the timing does not correspond to the decline in malaria cases seeking care at health facilities, and this alternative explanation does not account for why the decline in malaria cases would be larger in Ebola-affected areas. Also, although changes in recording and reporting could explain the reductions noted in the surveillance data, the concordance between the surveillance data and directly abstracted registry data contradicts a systematic change in malaria reporting as an alternative hypothesis.

Taken together, the decline in attendance at health facilities and in the numbers of patients treated with antimalarial drugs at health facilities and the suspension of community health workers' activities represent a major challenge for malaria care delivery in Guinea. Before the Ebola-virus-disease epidemic, the formal public sector was the most common source of care for febrile illness in children (57%), with the most common alternatives being traditional healers (13%) and private pharmacies (8%).<sup>8</sup> The two major avenues for delivering life-saving medicine to patients with malaria—public health facilities and community health workers—have been substantially compromised by the Ebola-virus-disease epidemic. Efforts to reinforce malaria care delivery in Guinea should be focused on reconnecting health-care workers and health facilities with the communities they serve and whose trust they need to regain. Similarly, community health workers who are currently inactive or have left their unpaid malaria case management duties to be paid Ebola-virus-disease contact tracers should be incentivised and provided the means to continue safely delivering malaria care in the community even as they continue their Ebola-virus-disease-related activities.

These interventions cannot wait until the last case of Ebola virus disease. Already, a substantial number of malaria cases have gone untreated or inappropriately treated. Although subject to much uncertainty, according to the estimations from expert opinion surveys the risk of an untreated and uncomplicated malaria case progressing to severe malaria ranges from 3% to 30% (depending on age and malaria endemicity) and then dying from severe malaria ranges from 45% to 73%.<sup>13</sup> Assuming the estimated 74 000 malaria cases not receiving malaria care at health facilities due to the Ebola-virus-disease epidemic (likely to be an underestimate because of the incompleteness of the weekly surveillance system) received no care or inappropriate care outside the formal health sector, excess malaria deaths are likely to greatly exceed the number of deaths from Ebola virus disease, consistent with findings from recent mathematical models.<sup>14</sup> Moreover, untreated malaria cases are likely to have contributed to an excess number of febrile episodes in the community and a greater number of suspected cases of Ebola virus disease requiring triage and isolation at over-burdened transit centres and Ebola treatment centres where uninfected people might have been exposed to Ebola virus disease. Malaria control efforts and malaria care delivery must be sustained and even heightened during an Ebola-virus-disease epidemic.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.



## Acknowledgments

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## Research in context

### Evidence before this study

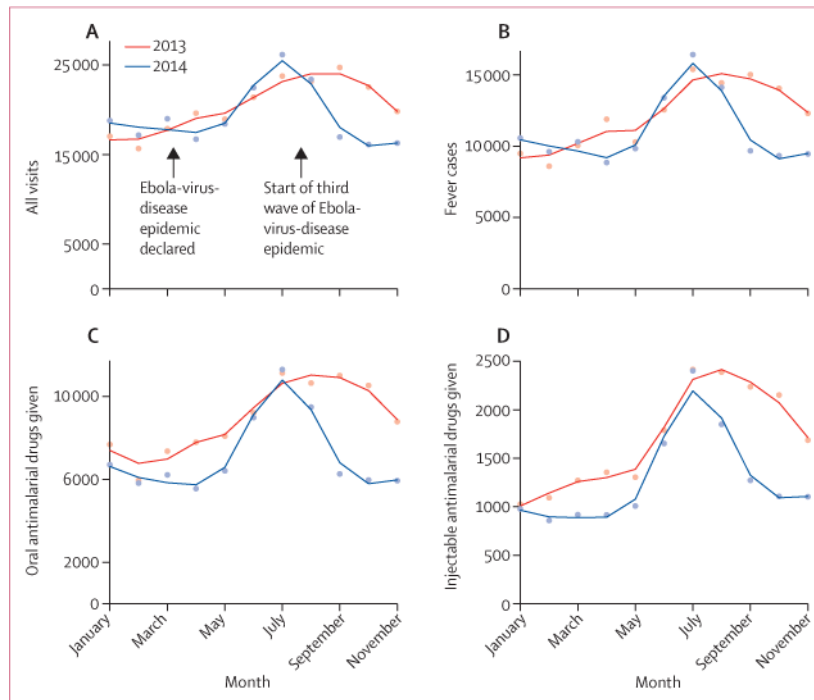
We searched PubMed with the search terms “Ebola”, “malaria”, “impact”, “indirect”, and “healthcare utilization”, in both French and English for the period (from March 1, 2013, to March 15, 2014) since the start of the Ebola-virus-disease epidemic in west Africa. We found one peer-reviewed published report with systematically gathered data about the effect of the Ebola epidemic on health-care delivery, showing a reduction in the use of inpatient services in Sierra Leone. We also found a modelling report of the estimation of excess malaria morbidity and mortality caused by the Ebola epidemic.

### Added value of this study

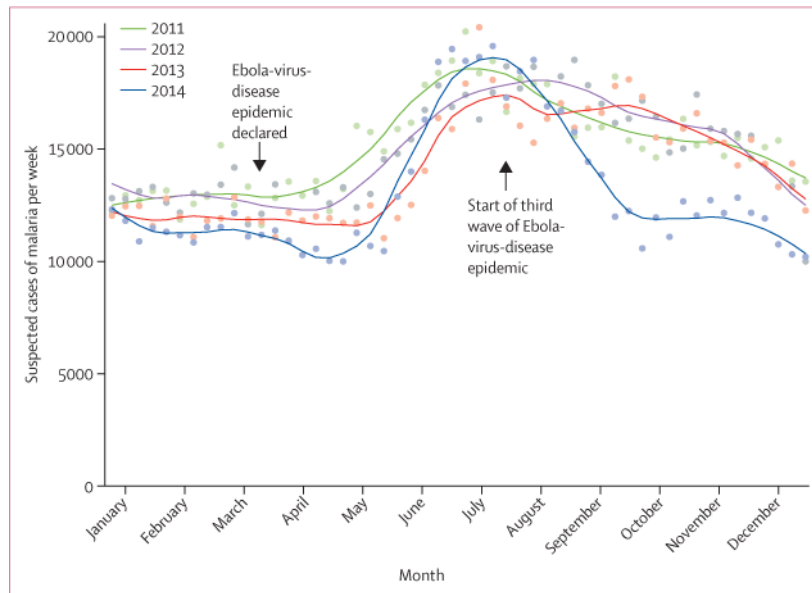
This study is the first systematic analysis of outpatient health-care use in an Ebola-affected country during the current outbreak. We focused specifically on malaria, the main cause of fever and health-care demand in Guinea. We documented changes in malaria case management practices since the start of the epidemic, quantified the reduction in the delivery of malaria care since the start of the Ebola-virus-disease epidemic, and estimated the excess malaria morbidity and mortality due to the Ebola-virus-disease epidemic, which greatly exceed the morbidity and mortality rates directly due to Ebola virus disease. The large sample size of this study, both in terms of health facilities sampled and patients’ records reviewed, comparison of Ebola-unaffected and Ebola-affected prefectures, long retrospective review, and confirmation of national surveillance data with survey data from systematically sampled health facilities contribute to the robustness of the findings.

### Implications of all the available evidence

The indirect effects of the Ebola-virus-disease epidemic, particularly those on malaria care delivery, lend support for strengthening health-care delivery in the context of Ebola virus disease. The significant effect of the Ebola-virus-disease epidemic on malaria morbidity and mortality rates should be considered by ministries of health and donors when allocating sparse health-care resources.



**Figure 1.** Comparison of the total monthly number of all-cause outpatient visits (A), cases of fever (B), patients treated with oral antimalarial drugs (C), and patients treated with injectable antimalarial drugs for severe malaria (D) recorded in registers in selected health facilities in Guinea for January to November in 2013 and 2014



**Figure 2. Suspect malaria cases per week for all prefectures in Guinea from January, 2011, to December, 2014**

Dots represent the suspect malaria cases, reported through telephone-based weekly surveillance system, and the lines indicate the locally weighted scatterplot smoothing fit.

**Table 1**

Health facilities visited during health facility survey in Guinea in 2014

	<u>Ebola-unaffected prefectures</u>		<u>Ebola-affected prefectures</u>			
	Sampled	Operational %	Sampled	Operational %		
All health facilities	60	58	97	60	55	92
Hospital	4	4	100	4	3	75
Health centre	27	27	100	30	29	97
Health post	29	27	93	26	23	88

Changes in malaria indicators from 2013 to 2014 at surveyed health facilities, stratified by time and zone

**Table 2**

	Ebola-unaaffected prefectures from 2013 to 2014				Ebola-affected prefectures from 2013 to 2014			
	January to March	April to July	August to November	January to November	January to March	April to July	August to November	August to November
<b>Adults and children (age ≥ 5 years)</b>								
All-cause patient visits	5%	10%	-6%	10%	10%	-22%	-42%	-42%
Fever cases	-2%	12%	-16%	-2%	-2%	-32%	-46%	-46%
Tested for malaria	73%	80%	23%	32%	32%	-9%	-23%	-23%
Confirmed cases of malaria	72%	75%	36%	32%	32%	-21%	-35%	-35%
Treated with oral antimalarial drugs	-13%	8%	-21%	-21%	-21%	-42%	-58%	-58%
Treated with injectable antimalarial drugs	-12%	21%	-17%	-40%	-40%	-44%	-69%	-69%
<b>Children (age &lt;5 years)</b>								
All-cause patient visits	7%	18%	-17%	-16%	-16%	-9%	-17%	-17%
Fever cases	9%	18%	-21%	-4%	-4%	-17%	-24%	-24%
Tested for malaria	63%	77%	27%	37%	37%	20%	7%	7%
Confirmed cases of malaria	54%	57%	39%	22%	22%	26%	0%	0%
Treated with oral antimalarial drugs	-4%	15%	-19%	-8%	-8%	-19%	-35%	-35%
Treated with injectable antimalarial drugs	-22%	-24%	-28%	-25%	-25%	-24%	-62%	-62%
<b>Pregnant women</b>								
Antenatal visits	4%	9%	14%	4%	4%	6%	-26%	-26%
Doses of sulfadoxine-pyrimethamine given during antenatal clinic visits	28%	33%	15%	37%	37%	59%	37%	37%

Numbers used to calculate the percentage changes are reported in the appendix.



**Table 3** Malaria case management practices at surveyed health facilities in November, 2013, and November, 2014

	Ebola-unaaffected prefectures		Ebola-affected prefectures		p value <sup>‡</sup>
	November, 2013	November, 2014	November, 2013	November, 2014	
Individual patient visits assessed	1987	2116	1870	1853	
Fever cases among all patient visits	68% (65–71)	65% (62–67)	71% (68–74)	57% (54–60)	<0.0001
Laboratory testing of fever cases	37% (34–40)	65% (62–68)	47% (44–51)	45% (41–49)	0.4
Rapid diagnostic test for malaria	29% (26–32)	63% (60–67)	41% (37–44)	42% (38–46)	<0.0001
Microscopy	8% (6–10)	2% (1–3)	4% (3–5)	2% (1–3)	0.01
Test positivity rate	82% (77–85)	72% (68–75)	73% (68–78)	73% (68–78)	1
Antimalarial treatment of fever	50% (46–53)	53% (49–56)	62% (58–65)	54% (50–58)	0.007
Presumptive treatment (no test)	24% (21–27)	21% (19–25)	32% (29–35)	23% (20–26)	<0.0001
Correct treatment (positive test)	81% (76–85)	75% (70–79)	84% (80–88)	86% (81–89)	0.6
Incorrect treatment (negative test)	14% (7–24)	5% (3–8)	27% (17–39)	19% (13–28)	0.2

Data are percentages (95% CI), unless otherwise indicated.

\* Comparison of November, 2013, and November, 2014, in unaffected prefectures.

† Comparison of November, 2013, and November, 2014, in affected prefectures.

‡ Comparison of change between 2013 and 2014 in affected and unaffected prefectures with difference-in-differences analysis.

**Table 4** Change in malaria case management practices reported by interviewed community health workers, November, 2014, in Guinea

	Ebola-unaffected prefectures		Ebola-affected prefectures		p value <sup>‡</sup>
	Before Ebola	Since Ebola	Before Ebola	Since Ebola	
Engaged in any activity	89/114 (78%, 69–85)	106/112 (95%, 89–98)	96/98 (98%, 93–100)	73/98 (74%, 65–83)	0.0001
Community mobilisation	87/89 (98%, 92–100)	104/106 (98%, 93–100)	94/96 (98%, 93–100)	72/73 (99%, 93–100)	0.7
Case management of malaria	56/89 (63%, 52–73)	102/106 (96%, 91–99)	65/96 (68%, 57–77)	35/73 (48%, 36–60)	0.003
Other	0/89 (0%)	13/106 (12%, 7–20)	32/96 (33%, 24–44)	32/73 (44%, 32–56)	<0.0001
Use of rapid diagnostic test for malaria diagnosis	57/95 (60%, 49–70)	104/109 (95%, 90–98)	69/98 (70%, 60–79)	29/97 (30%, 21–40)	<0.0001
Use of gloves with rapid diagnostic test	49/57 (86%, 74–94)	94/104 (90%, 83–95)	56/69 (81%, 70–90)	27/28 (96%, 82–100)	0.09
Presumptive treatment of malaria cases	11/95 (12%, 6–20)	3/109 (3%, 1–8)	9/98 (9%, 4–17)	11/97 (11%, 6–19)	0.6
Referral of fever cases to health facility	86/95 (91%, 83–96)	84/109 (77%, 68–85)	89/98 (91%, 83–96)	92/97 (95%, 88–98)	0.2

Data are n/N (%; 95% CI).

\* Comparison of practices before and since the start of the 2014 Ebola epidemic in unaffected prefectures.

† Comparison of practices before and since the start of the 2014 Ebola epidemic in affected prefectures.

‡ Comparison of the change in practices before and since the start of the 2014 Ebola epidemic in affected and unaffected prefectures with difference-in-differences analysis.