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The quality of malaria care in 25 low-income and middle-income countries

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ABSTRACT

Introduction Even with accessible and effective diagnostic tests and treatment, malaria remains a leading cause of death among children under five. Malaria case management requires prompt diagnosis and correct treatment but the degree to which this happens in low-income and middle-income countries (LMICs) remains largely unknown.

Methods Cross-sectional study of 132 566 children under five, of which 25% reported fever in the last 2 weeks from 2006 to 2017 using the latest Malaria Indicators Survey data across 25 malaria-endemic countries. We calculated the per cent of patient encounters of febrile children under five that received poor quality of care (no blood testing, less or more than two antimalarial drugs and delayed treatment provision) across each treatment cascade and region.

Results Across the study countries, 48 316 (58%) of patient encounters of febrile children under five received poor quality of care for suspected malaria. When comparing by treatment cascade, 62% of cases were not blood tested despite reporting fever in the last 2 weeks, 82% did not receive any antimalarial drug, 17% received one drug and 72% received treatment more than 24 hours after onset of fever. Of the four countries where we had more detailed malaria testing data, we found that 35% of patients were incorrectly managed (26% were undertreated, while 9% were overtreated). Poor malaria care quality varies widely within and between countries.

Conclusion Quality of malaria care remains poor and varies widely in endemic LMICs. Treatments are often prescribed regardless of malaria test results, suggesting that presumptive diagnosis is still commonly practiced among cases of suspected malaria, rather than the WHO recommendation of 'test and treat'. To reach the 2030 global malaria goal of reducing mortality rates by at least 90%, focussing on improving the quality of malaria care is needed.

Key questions

What is already known?

- While an extensive array of evidence about access to malaria care insecticide-treated bed nets, diagnostics and treatments, as well as quality of malaria diagnostic tests and drugs are available, we know much less about the quality of malaria care provision and how quality of malaria care compares across low-incomeand middle-income countries (LMICs).

What are the new findings?

- Quality of malaria care remains poor in many LMICs despite increasing access to malaria care tests and treatment drugs.
- Quality of care varies across the treatment cascade with febrile children often not receiving blood tests, resulting to improper treatment of malaria; thus, treatments are often prescribed regardless of malaria test results.
- Poor quality of malaria care also varies widely by regions with capital cities not necessarily providing better quality of malaria care than others.

What do the new findings imply?

- Our findings suggest that the quality of malaria for children under five in many LMICs is quite low and that quality of care varies by malaria treatment cascade and regions.
- There is both undertreatment and overtreatment, regardless of malaria test results, requiring the need to strengthen future quality improvement strategies to ensure prompt and correct malaria testing and treatment across countries.

INTRODUCTION

Malaria represents one of the leading burdens of illness among children, ranking among the major health and development challenges for many low-income and middle-income countries (LMICs). Overall, there were an estimated 219 million malaria cases in 2017 across 91 countries, a number that is actually increasing (an estimated 5% increase from 2016).[1] More than 60% of all malaria deaths occur in children under the age of five and despite progress in this population, malaria remains a major killer, with about 300 000 children dying every year.[2] To reduce malaria deaths, early diagnosis and prompt, effective treatment is essential,[1] and improved access to care through universal coverage is considered critical. However, there is some data to suggest that inadequate testing of febrile children and generally poor quality of malaria care, defined in this study as providing malaria drugs without blood testing for malaria, receiving more than the

recommended antimalarial drugs, or receiving delayed malaria treatment, may be a substantial hindrance to reducing malaria mortality. Given these concerns, estimating poor malaria care quality is particularly important, but recent studies[3] were not able to quantify this. Without knowing how rampant poor quality of care is, the stated WHO global target of reducing mortality by 90% by 2030 remains unachievable.[2]

The degree to which poor quality care is a barrier to reducing malaria deaths is largely unknown, partly because we know very little about the quality of malaria care in LMICs (online supplementary appendix 1). There have been a few studies examining these issues[4–10] though they are limited by the lack of comparable quality of care data across countries. A few more comprehensive studies of quality of care in LMICs have excluded malaria in their evaluations.[11 12] Despite its central importance, we have a surprisingly incomplete picture of the quality of malaria care, how it varies across settings, and where on the diagnosis and treatment cascade the failures occur. This kind of information is critical to help policymakers better decide both how much to focus on quality and where in the clinical process that attention should be emphasised. Empirical evidence here would be very helpful.

New and comparable data on malaria care testing and treatment across LMICs were recently collected and made available through the Roll Back Malaria programme. Using their latest available data for malaria endemic LMICs, we sought to answer three questions: First, what is the quality of malaria care in 25 malaria-endemic LMICs? Second, what is the distribution of that poor quality of care across the treatment cascade? And, finally, how does the poor quality of care vary across the regions of each study country?

METHODS

We conducted a cross-sectional study in 25 malaria-endemic countries (Angola, Burkina Faso, Burundi, Cambodia, Cameroon, Ethiopia, Gambia, Ghana, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Nigeria, Rwanda, Senegal, Sierra Leone, Swaziland, Tanzania, Togo, Uganda, Zambia and Zimbabwe) using the most recent malaria survey data from 2006 to 2017.

Study population and data sources

We gathered cross-sectional survey data on 132 566 under-five children in 25 malaria-endemic LMICs (online supplementary appendix 2), of which children who were febrile in the last 2 weeks and who sought care for reported fever were selected to assess malaria care quality (online supplementary appendix 3). Data were obtained from the most recent Malaria Indicators Surveys (MIS) from 2006 to 2017, which are nationally-representative, population-based sample surveys collecting data on insecticide-treated nets, patterns of diagnostic testing and antimalarial use among malaria-endemic countries. The MIS sample was selected using a stratified two-stage cluster design.[13] The first stage involved clusters with probability proportional to size from the list of enumeration areas covered in the population and housing census. In the second stage, for all the selected enumeration areas, households were randomly selected using an equal probability systematic sampling. MIS include two types of data: women's and biomarker questionnaires. The women's questionnaire found in 25 countries was used to assess care seeking, diagnostic testing and access to prompt treatment with antimalarials for under-five children with fever as reported by women interviewed. The biomarker questionnaire available in four of the 25 study countries confirms malaria using malaria rapid diagnostic tests (mRDTs) or blood smear test results. The biomarker data were used to reduce potential recall and misclassification bias on the diagnosis of malaria obtained from the women's questionnaire. Bias due to missing data is unlikely to have affected our results substantially because our findings were relatively similar when we analysed only patients with complete data and when assessing quality of care using other outcome measures (Appendices 4 to 7: Sensitivity analyses).

Variables

Among febrile under-five children who sought care, we used variables that were relevant to the WHO recommendations on malaria care, including whether or not they had their blood tested for fever, whether or not they had been treated for malaria with one antimalarial drug or more than three antimalarial drugs and whether or not they received malaria care within 24 hours from the onset of fever. It would have been ideal to determine timely care by examining whether or not they received malaria care within 24 hours from the time they sought care or when they first saw a healthcare provider. Unfortunately, existing data only provide time from the onset of fever. Responses were either yes or no based on mother's recall of the treatment of their febrile child in the last 2 weeks.

Main outcome measure

Our unit of analysis is a patient encounter, which refers to any distinct interaction of a patient with a provider at any point of the treatment cascade. One patient may have more than one encounter, representing different types of care along the treatment cascade where the provider can follow WHO recommended care or not. Our primary outcome was guided by WHO-recommendations and was calculated as the proportion of patient encounters with poor quality defined as the number of times a patient interacted with a health provider and received care that did not follow the WHO recommendations for any of the three treatment cascades (malaria testing, malaria treatment provision and malaria treatment timeliness). Online supplementary appendix 3 details how poor malaria care quality is defined in this study.

Statistical analysis

First, we report summary statistics (number of under-five children, wealth and education) of the study countries corresponding to each survey year and then compared survey estimates to the estimates from country reports to examine sample representativeness. Second, we compared the percentages of febrile children who sought care to those who did not seek any medical care. Third, limiting our analysis to febrile children who sought medical care, we then calculated the percentage of poor malaria care quality overall and for each treatment cascade by calculating the total number of times the patient received inappropriate care out of all instances wherein a patient may have gone through a treatment cascade (malaria testing, treatment and timeliness). For malaria testing, an encounter is considered of poor quality if no blood test through either mRDTs or blood smears were done before treatment.[14] For malaria treatment provision, an encounter is considered to be poor quality if the child did not receive any antimalarial treatment (no treatment), received only one antimalarial drug (inadequate treatment)[15] or three or more antimalarial drugs (overtreatment). For malaria treatment timeliness, an encounter is considered to be of poor quality if the patient is treated more than 24 hours from the onset of fever (delayed treatment). To calculate the overall burden of poor malaria care quality, patient encounters with poor malaria care quality were summed and divided by the total possible treatment cascades a patient may have gone through. We also conducted a secondary analysis calculating the proportion of cases that were undertreated and overtreated using additional laboratory test results from four of the 25 study countries with available data. We also mapped the calculated percentages of patient encounters with problems on malaria care quality by regions of each study country. Since some countries did not have more recent data, we correlated poor quality of care with other population characteristics such as gross domestic product per capita, year of survey and per cent of febrile children out of total population.

We limited all our analyses to under-five children who reported fever in the last 2 weeks. We used the survey weights to make the sample representative of the country and eliminate the potential non-proportional allocation of the sample.[16] The biomarker data available for four of the 25 countries, including repeating the analysis only for those who had complete data or who went through all the treatment cascades, were used for additional sensitivity analyses (Appendices 5 to 7). All analyses were done in Stata V.15.1. Maps were created using ArcGIS V.10.6.1.

Patient and public involvement

No patients were involved in setting the research question or the outcome measures, nor were they involved in developing plans for the design or implementation of the study. No patients were asked to advise on interpretation or writing up of results. There are no plans to disseminate the results of the research to study participants or the relevant patient community.

Role of the funding source

The authors received no specific funding for this work. All authors had full access to all the data in the study and had the final responsibility for the decision to submit for publication.

RESULTS

Results are divided into two sections: (a) a data gap analysis on malaria care quality, and (b) estimation of poor malaria care quality using existing available and most complete data.

Data gap analysis on malaria care quality

We found that despite existing nationally representative surveys specifically focussed on malaria such as the Malaria Indicators Survey, there are still limited data to quantify quality of malaria care by treatment cascade. Thus, malaria surveys still do not comprehensively capture malaria care quality. First, reasons for not seeking care were not provided by the survey, which could have been important information to improve access to malaria care. Second, data on blood testing were not available for four malaria-endemic countries (Cameroon, Ethiopia, Swaziland and Senegal). Similarly, only four of the 25 study countries had available data on malaria test results to confirm appropriate treatment route for febrile children under five. Third, data were based on mother's recall of the antimalarial drugs taken by their child instead of the actual doctor's prescriptions; thus, this may not completely reflect the treatment process. Lastly, future surveys can follow children not only throughout the cascade, but also once the treatment is complete to know the consequences of the quality of malaria care treatment received by the child. Similarly, patient history is lacking in most surveys and should be made available since recurrence of malaria may impact how the malaria care treatment is provided by a healthcare worker. Considering these data gaps, our findings shown in the succeeding sections estimate malaria care quality where data are most complete and where reasonable assumptions can be made to provide the critical evidence on how poor malaria care quality is in the study countries.

Characteristics of sampled children under five and their households

Our survey sample totalled 132 566 children under five from each latest available survey from 2006 to 2017 (table 1). Of these children, a mean across countries of 23% belong to households in the lowest wealth index and a mean of 28% belong to households in the wealthiest index. Our sample had 5% more children belonging to the poorest and 6% more belonging to the wealthiest compared with country reported estimates. A mean of 16% of our survey sample lives in urban areas, compared with the 24% reported in the country estimates. Of the children's mothers, a mean

Table 1 Survey characteristics and socioeconomic profile of under-five children and their households

Country	Year	Number of under-five children	Proportion belonging to poorest wealth index		Proportion urban		Proportion of mothers who attained primary education or less	
		Survey	Survey	Country reports	Survey	Country reports	Survey	Country reports
Angola	2011	3025	24%	11%	12%	33%	90%	81%
Burkina Faso	2014	6324	21%	18%	16%	25%	92%	82%
Burundi	2012	3984	23%	20%	18%	21%	93%	84%
Cambodia	2005	3796	25%	–	17%	–	82%	–
Cameroon*	2011	5286	23%	18%	16%	17%	69%	53%
Ethiopia*	2016	9696	24%	16%	14%	23%	93%	83%
Gambia*	2013	3640	21%	16%	17%	2%	73%	–
Ghana	2016	3034	22%	16%	18%	24%	47%	36%
Kenya	2015	3356	26%	16%	18%	27%	65%	54%
Liberia	2016	2611	23%	16%	16%	25%	65%	56%
Madagascar	2016	6832	25%	18%	16%	24%	74%	65%
Malawi	2017	3694	23%	19%	18%	23%	82%	77%
Mali	2015	7302	21%	–	17%	–	89%	–
Mozambique*	2015	4843	23%	35%	14%	48%	84%	–
Namibia*	2013	1945	25%	–	14%	–	31%	–
Nigeria	2015	6161	21%	18%	19%	23%	63%	54%
Rwanda	2013	3018	23%	19%	17%	23%	90%	81%
Senegal	2009	13884	23%	17%	16%	24%	92%	82%
Sierra Leone	2016	5720	22%	18%	16%	24%	75%	66%
Swaziland*	2007	2226	22%	–	17%	–	45%	–
Tanzania*	2012	7054	23%	17%	16%	26%	92%	30%
Togo	2017	3271	23%	17%	18%	24%	73%	63%
Uganda	2015	4300	23%	18%	17%	25%	78%	69%
Zambia	2014	12311	24%	–	15%	–	67%	63%
Zimbabwe	2015	5253	24%	–	17%	–	33%	–
Total		132 566†						
Mean			23%	18%	16%	24%	73%	66%

Data source: Calculated data were from 2005 to 2017 Malaria Indicators Survey, Reported data were from the Country Reports. See online supplementary appendix.
*Only biomarkers data are available.
†Total number of under-five children was calculated using survey weights.

of 73% attained primary education or had no formal education, greater by 7% than the reported country estimates. The difference between the survey and the country estimates was found to be insignificant (p>0.05); thus, our sample is nationally representative.

Care seeking among febrile children under five

Of the 132566 children surveyed, a mean of 25% of children reported fever in the last 2 weeks (figure 1a). Of these febrile children, a mean of 19% (n=6436) did not seek care for fever. The highest percentages of children who did not seek care for fever were in Ethiopia (53%, n=717), Burundi (36%, n=609) and Zimbabwe (35%, n=264). The lowest percentages of children who did not seek care for fever were in Uganda (5%, n=65), Ghana (6%, n=52) and Sierra Leone (8%, n=123).

Burden of poor quality of malaria care

Overall, 58% of patient encounters (n=59920) reported having poor malaria care quality (figure 1b). The highest percentages of patient encounters with poor quality were in Tanzania (69%, n=2925), Nigeria (66%, n=4320) and Mozambique (65%, n=1983). The lowest percentages were in Liberia (48%, n=1322), Sierra Leone (49%, n=2204) and Zambia (50%, n=3581). The estimated 58% of patient encounters receiving poor malaria care quality reduced to 35% when considering only the four countries (Angola, Ghana, Nigeria and Senegal) that had

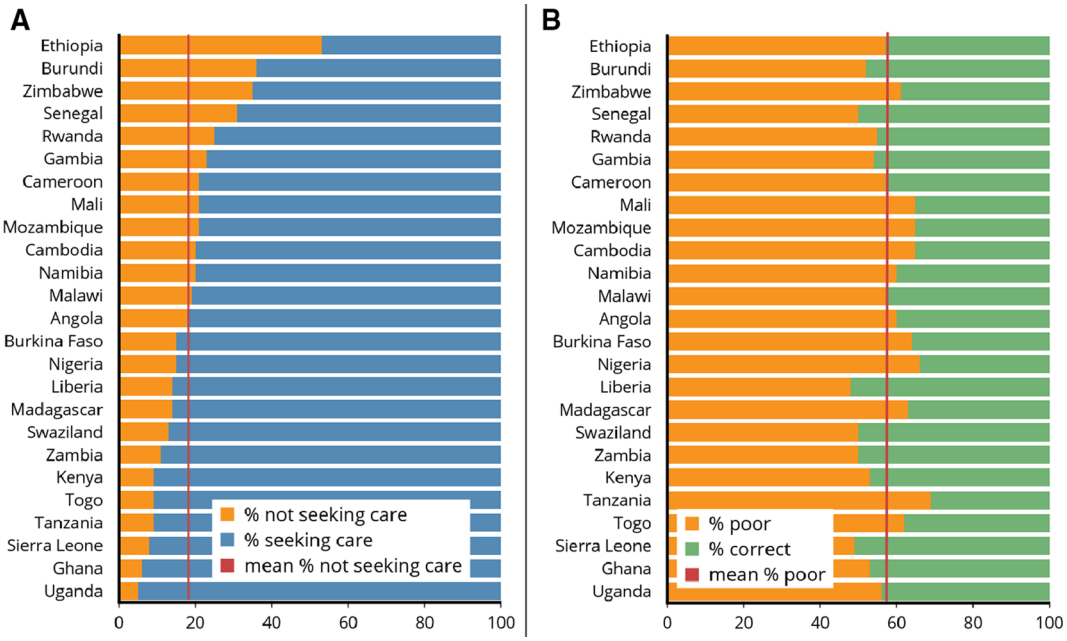

Figure 1 Care seeking behaviour and quality problems in malaria care among febrile children under five. (A) Percentage of cases of under-five children who did not seek care versus those that sought care. (B) Among those seeking care, number of patient encounters with problems on quality of malaria care. Note: There is no available information on blood testing in Cameroon, Ethiopia, Senegal and Swaziland. Inadequate treatment refers to the number of patient encounters wherein children were treated with one antimalarial drug, which does not include artemisinin or combination therapies. Red line = mean for all the study countries.

additional malaria laboratory test results (online supplementary appendix 4). About 26% (n=1992) were due to undertreatment and 9% (n=952) were due to overtreatment. Large percentages were still found even when using different estimation methods (Appendices 5 to 7: Sensitivity analyses). In assessing whether poor quality of care is associated with the survey characteristics, our tests showed weak correlations between poor malaria care quality and gross domestic product (GDP) per capita (correlation=−0.010), per cent of febrile children out of the total population of children under five (correlation=−0.361) and year of survey (correlation=0.209).

Quality of malaria care by treatment cascade

When comparing quality of malaria care by treatment cascade (malaria testing, treatment and treatment timeliness), we found that: First, a mean of 62% of febrile children were reported not to have any blood test for fever. The highest percentages of children who did not have a blood test were in Cambodia (93%, n=985), Zimbabwe (83%, n=401) and Nigeria (82%, n=1807). The lowest percentages without a blood test were in Liberia (32%, n=813), Zambia (41%, n=996) and Sierra Leone (43%, n=638). We found no available information on blood testing in Cameroon, Ethiopia, Senegal and Swaziland. Second, for antimalarial use, a mean of 82% of febrile children who sought care reported that they did not receive any treatment drug and 17% reported receiving one antimalarial drug. Specifically, all but one case in Cambodia reporting not having any antimalarial treatment (100%), while Tanzania had the lowest record for no treatment at 44%. For inadequate treatment, 56% of cases in Tanzania were treated with one antimalarial drug, while Cambodia had one case treated with one antimalarial drug. Third, for treatment timeliness, a mean of 72% of febrile children with treatment encounter received care after 24 hours from onset of fever. Of those who received delayed treatment, 15% received care after 3 days, the longest delay recorded was in 9 days. All treated cases in Cambodia, Ethiopia, Mozambique and Swaziland received delayed treatment, while the lowest recorded was half of all treated cases in Burundi and Zimbabwe (figure 2 and table 2).

Quality of malaria care by regions

Quality of malaria care varies by 11% to 30% when comparing across regions of each study country (figure 3, Appendices 8 and 9). The highest regional difference of 30% in quality of malaria care was in Tanzania. In Tanzania, the highest percentages of patient encounters with problems on malaria care quality were in Simiyu (81%, n=216), Shinyanga (77%, n=167) and Mara (76%, n=252), while the lowest were in Zanzibar North (52%), Dar es salaam (55%) and Pwani (55%). Across the study countries, the lowest regional percentages estimated were in Ghana: Upper East (41%, n=136), Upper West (45%, n=100) and Brong Ahafo (46%, n=154).

DISCUSSION

Across the 25 study countries, we found that 58% (48% to 68%) of patient encounters of children under 5 years of age with suspected malaria met the criteria for poor

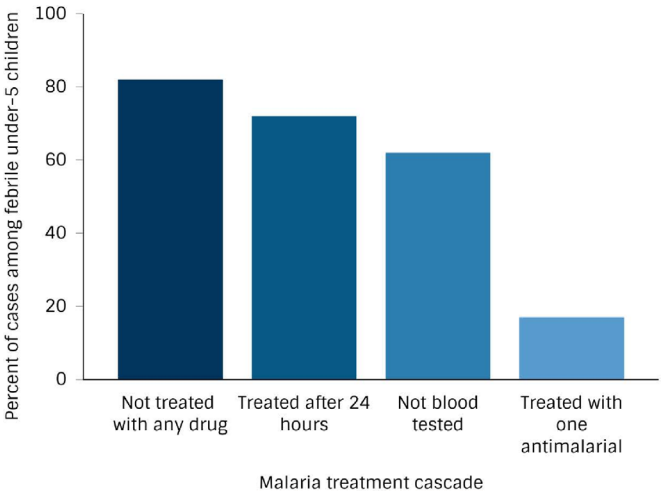

Figure 2 Percent of cases among febrile children under five by malaria treatment cascade defined as: reported not receiving any drug treatment, reported being treated after 24 hours, reported not receiving any blood test, or reported being treated with one antimalarial drug. All percentages were calculated as number of febrile children under five out of all reported patient encounters.

quality care. Specifically, we noted that only about two out of five patients were blood tested prior to treatment as recommended by the universal 'test and treat' WHO strategy for malaria. Consequently, in about four out of five patient encounters, a child was treated with inappropriate antimalarial drugs and more than half had delayed treatment. We also found large variations in quality of malaria care across countries and regions. Taken together, quality of malaria care remains poor in many malaria-endemic LMICs and widely varies by treatment cascade and geography, suggesting that increasing access to care alone may not be sufficient to reduce malaria mortality rates.

When care is accessible, we found that children often receive inappropriate care. This variation ranges from diagnostics to therapies. It is true that WHO used to suggest presumptive treatment but given the rise of ineffective and wasteful use of antimalarial drugs,[14] WHO's approach has become more cautious. Globally, investments for mRDTs alone is as high as US$213 million last year, but its use in malaria care is perceived as unreliable especially in high transmission areas.[17] In high transmission areas, parasitological diagnosis was argued to have lower specificity and the cost of testing may be higher than the cost of treatment.[17] Thus, this lack of adherence or compliance to testing requirements may be driven not just by the lack of availability of diagnostic tests, but also by providers' perceptions that the benefits of treating based on clinical symptoms rather than test results outweigh the risks.[18 19] Previous studies noted that RDTs also remain positive for a highly variable amount of time after treatment with antimalarials (up to 60 days after treatment), and the duration of positivity is highly dependent on the type of RDT used for diagnosis.[20] Further, the quality of RDTs was found to be affected by regular exposure to temperatures above recommended limits, underlining the need to also revisit current global standards on transport and storage of such medical commodities.[21] These are important issues policymakers need to further tackle.

We found important gaps in treatment practices as well—with about two out of three malaria cases being incorrectly managed, much of it due to substantial delays in treatment. Evidence so far shows that this may be due to inadequate guideline emphasis[22] or simply lack of knowledge among providers regarding malaria case management.[23] In our study countries, we found that undertreatment (26%), specifically monotherapy, was higher than overtreatment (9%) of malaria cases, but both lead to unnecessary wastes in the health system. If undertreated, uncomplicated malaria cases can progress rapidly to fatal malaria.[14] If overtreated, subjecting patients to unnecessary antimalarial drugs or improper combination of them only increase costs to health systems and put more peoples' lives at risk of antibiotic resistance. Of those who were overtreated, 13% of children were also found to receive an antimalarial drug even with a negative malaria test result. Inappropriate treatment practices are further exacerbated by delays in treatment that can be caused by both access and quality issues, recorded to be as delayed as 9 days from the onset of fever in some study countries. In Burkina Faso, treatment delays were found to be due to the patient's capacity to afford the cost of care.[24] Some studies have found that integrated community case management using home-based care and abolition of user fees may reduce treatment delays.[24 25]

Designing an intervention to reduce poor malaria care quality is beyond the scope of this study, but these findings quantifying the degree and location in the treatment cascade of poor malaria care quality provide evidence for increased attention on malaria quality of care. Thus, malaria strategies should include interventions to address quality of care. Generally, malaria resource allocation is based on malaria endemicity, wherein more resources for malaria testing and treatment are targeted in high transmission areas. However, our additional analyses showed that malaria endemicity as a proxy for resource allocation was not correlated with quality of care (correlation=−0.01, online supplementary appendix). Thus, such resource allocation may not necessarily be translated to better quality of malaria care, suggesting that increasing diagnostic tools and antimalarial drugs alone are not enough.

At the regional level, estimating disparities on malaria care quality provides a more detailed picture of the hotspots of poor malaria care (online supplementary appendix 8 and 9). Our findings in Uganda showing 60% poor malaria care quality are reflective of previous findings that adherence to Ugandan national malaria treatment guidelines was only at 50.6% in 2016,[26] with about 15% of providers not knowing the first-line treatment for uncomplicated malaria.[27] Similarly, being in the capitals of these countries does not translate to better quality of malaria care as supported by previous literature.[28] Regional disparities in malaria care quality may

Table 2 Problems with malaria care quality among febrile under five children in 25 LMICs by treatment cascade

	Not blood tested*		Not treated with any drug†		Treated with only one malarial drug†		Receipt of treatment after 24 hours‡	
Country	N	%	N	%	N	%	N	%
Tanzania (n=1413)	1035	73%	614	44%	781	56%	476	61%
Nigeria (n=2213)	1807	82%	1465	69%	623	29%	425	63%
Mozambique (n=1018)	496	49%	563	56%	434	43%	435	100%
Mali (n=1655)	1363	82%	1193	75%	366	23%	283	71%
Cambodia (n=1062)	985	93%	1060	100%	1	0%	1	100%
Burkina Faso (n=2200)	1367	62%	1240	57%	903	41%	609	65%
Madagascar (n=899)	726	81%	818	91%	79	9%	64	79%
Togo (n=708)	453	64%	476	68%	224	32%	149	66%
Zimbabwe (n=486)	401	83%	477	98%	6	1%	4	50%
Angola (n=912)	516	57%	627	70%	264	30%	213	81%
Namibia (n=433)	332	77%	417	96%	13	3%	13	81%
Malawi (n=1082)	554	51%	754	71%	310	29%	174	56%
Cameroon (n=1204)			901	76%	283	24%	198	69%
Ethiopia (n=624)			532	86%	83	13%	85	100%
Uganda (n=1329)	822	62%	1184	89%	108	8%	81	56%
Rwanda (n=659)	400	61%	619	94%	37	6%	29	78%
Gambia (n=371)	221	60%	354	96%	14	4%	8	57%
Ghana (n=830)	418	50%	498	60%	172	21%	197	60%
Kenya (n=1146)	654	57%	1114	97%	25	2%	18	58%
Burundi (n=1068)	514	48%	930	87%	127	12%	69	50%
Swaziland (n=586)			582	99%	4	1%	4	100%
Senegal (n=2926)			2690	92%	167	6%	182	81%
Zambia (n=2411)	996	41%	2299	95%	107	4%	87	78%
Sierra Leone (n=1495)	638	43%	1405	94%	68	5%	54	64%
Liberia (n=944)	298	32%	813	87%	108	12%	91	72%
Total (n=29 674)	14 996		23 625		5307		3949	
Mean		62%		82%		17%		72%

There is no available information on blood testing in Cameroon, Ethiopia, Senegal and Swaziland. All data were analysed using survey weights.
*Among those with fever reported in the last 2 weeks.
†Among those with fever reported in the last 2 weeks and had a treatment encounter.
‡Among those with fever reported in the last 2 weeks and were treated with any malarial drug.
LMICs, low-income and middle-income countries.

be driven by socioeconomic and regional characteristics (eg, funding, governance, human resource availability) which can be explored once data become available.

Our findings were consistent with previous studies that were mostly conducted in a subset of countries or regions. For malaria testing, a 2017 study in five sub-Saharan African countries found that an average of 87% of patients without a blood test had antimalarial drugs.[29] Our findings expanding the scope to 25 study countries showed a decline to 62% that were not blood tested. Although this may show some improvements in blood testing, more work still needs to be done in ensuring adherence to testing requirements. In treating malaria, compliance with the recommended first-line medication for uncomplicated malaria was also found to be low in many country-level studies.[30 31] A cross-country study showed that less than a third of fevers were treated according to the national guidelines and only about 40% on fevers on average (ranging from 8% to 72%) were managed effectively.[32] By expanding this previous cross-country study using more updated data, our findings showed similarly huge variations in care across countries (48% to 69%) and across regions (11% to 30%). Further, instead of simply aggregating poor quality of care in a summative measure, we were able to disentangle where quality of care was worse, highlighting the bottlenecks and system failures that need stronger quality improvement measures.

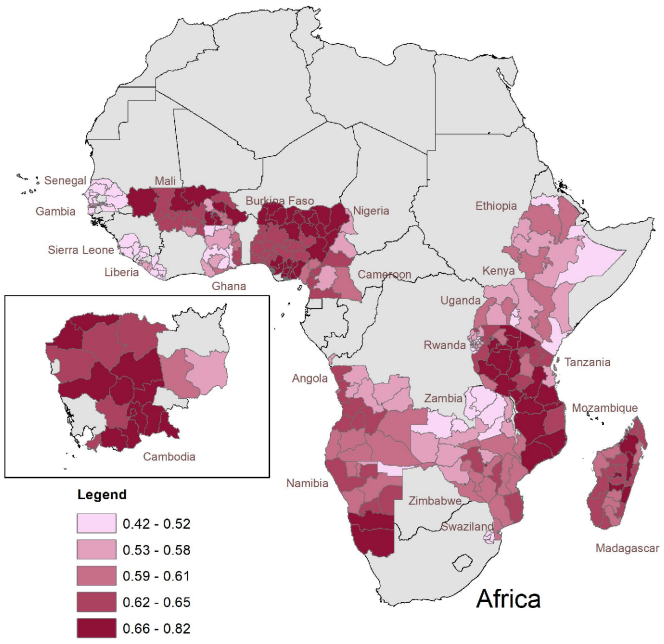

Figure 3 Quality of malaria care by region with 0 as lowest performing to 1 as highest performing region. In grey are areas not included in the study due to data availability or incomplete/missing information.

We also found that existing nationally representative malaria surveys still do not comprehensively capture malaria care quality, as discussed in our data gap analysis. We also noted patient encounters wherein only one antimalarial drug or more than three antimalarial drugs were given to a febrile child. Such data could have been improved if we were able to identify which antimalarial drug may have actually been given to the child during the treatment process. Consequently, the calculations for poor malaria care quality may be an overestimation given that we were not able to restrict our analysis based on test results and antimalarial drugs for all the 25 study countries. Nevertheless, the four study countries that had additional laboratory-confirmed malaria test results showed that treatment prescriptions were provided regardless of the test results (35% of cases, see online supplementary appendix). The findings also do not vary as much when using different estimation methods (online supplementary appendix). Thus, although we were limited by the availability of data that could have influenced the accuracy of the estimations, our findings provide evidence that poor malaria care quality occurs in large percentages in these malaria-endemic LMICs. Although we found weak correlations between quality of malaria care and survey characteristics (survey year, GDP per capita, per cent of febrile children), the estimations may have been reflective of the existing policies of the countries at the time of the survey; thus, this may not necessarily point to lack of accountability of the governments and the providers. Nevertheless, our findings showed that malaria care quality at that time is still poor in comparison to existing guidelines, providing evidence about the need to focus on strengthening implementation of malaria care policies in these countries. Future research will update our estimations and track progress on malaria care once more recent survey data become available, including any data on comorbidities of the febrile children. Although we noted weak correlations of GDP per capita and survey year on the estimations of poor malaria care quality, future research may further explore how other factors such as war, poverty and lack of qualified healthcare professionals may affect the quality of care, not only for malaria care, but generally across different populations. Since full implementation does not occur immediately after releasing a global guideline, future studies may also collect data on when each country has fully implemented the WHO guideline to assess changes in quality of malaria care pre-implementation and post-implementation.

CONCLUSION

In summary, malaria care quality remains poor across the 25 study countries with over half of patient encounters reportedly having poor malaria care quality. Quantifying the burden of poor malaria care quality is crucial, particularly at a time when global investment for malaria has plateaued and progress has stalled.[33] Our findings provided evidence that the WHO recommendation for all cases of suspected malaria to have a parasitological test before prescribing treatment is not being widely practiced. Although availability of mRDTs and antimalarial drugs are critical, ensuring adherence to quality malaria care is equally important.[27 34 35] Unless quality of malaria care is improved, malaria will continue to be one of the five leading causes of under-five mortality and the global goal of reducing malaria mortality rates by at least 90% by 2030 will remain unattainable for many LMICs.

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REFERENCES

1 WHO. *World malaria report 2018*. Geneva: World Health Organization, 2018.
2 WHO. *Malaria key facts*. World Health Organization, 2018.
3 Feachem RGA, Chen I, Akbari O, *et al*. Malaria eradication within a generation: ambitious, achievable, and necessary. *Lancet* 2019;394:1056–112.
4 Nayyar GML, Breman JG, Newton PN, *et al*. Poor-quality antimalarial drugs in Southeast Asia and sub-Saharan Africa. *Lancet Infect Dis* 2012;12:488–96.
5 Amexo M, Tolhurst R, Barnish G, *et al*. Malaria misdiagnosis: effects on the poor and vulnerable. *Lancet* 2004;364:1896–8.
6 Keoluangkhot V, Green MD, Nyadong L, *et al*. Impaired clinical response in a patient with uncomplicated falciparum malaria who received poor-quality and underdosed intramuscular artemether. *Am J Trop Med Hyg* 2008;78:552–5.
7 McMorrow ML, Masanja MI, Abdulla SMK, *et al*. Challenges in routine implementation and quality control of rapid diagnostic tests for malaria--Rufiji District, Tanzania. *Am J Trop Med Hyg* 2008;79:385–90.
8 Onwujekwe O, Hanson K, Uzochukwu B. Do poor people use poor quality providers? Evidence from the treatment of presumptive malaria in Nigeria. *Trop Med Int Heal* 2011;16:1087–98.
9 Reyburn H, Mbatia R, Drakeley C, *et al*. Overdiagnosis of malaria in patients with severe febrile illness in Tanzania: a prospective study. *BMJ* 2004;329:1212.
10 Bell D, Wongsrichanalai C, Barnwell JW. Ensuring quality and access for malaria diagnosis: how can it be achieved? *Nat Rev Microbiol* 2006;4:682–95.
11 National Academies of Sciences E and M. *Crossing the global quality chasm*. Washington, D.C.: National Academies Press, 2018.
12 Kruk ME, Gage AD, Arsenault C, *et al*. High-Quality health systems—time for a revolution: report F the Lancet global health Commission on high quality health systems in the SDG era. *Lancet Glob Heal* 2018.
13 Malaria Indicator Surveys - Access to Reports, MIS Datasets, Survey Information. Available: https://www.malariasurveys.org/surveys.cfm?country=Mozambique 2018#6084 [Accessed 9 Jul 2019].
14 World Health Organization. *Guidelines for the treatment of malaria*. 3rd edn. World Health Organization, 2017.
15 Ezenduka CC, Ogbonna BO, Ekwunife OI, *et al*. Drugs use pattern for uncomplicated malaria in medicine retail outlets in Enugu urban, Southeast Nigeria: implications for malaria treatment policy. *Malar J* 2014;13:243.
16 DHS. *Malaria indicator survey guidelines for sampling for the malaria indicator survey*, 2016.
17 Graz B, Willcox M, Szeless T, *et al*. "Test and treat" or presumptive treatment for malaria in high transmission situations? A reflection on the latest WHO guidelines. *Malar J* 2011;10:136.
18 Mbonye MK, Burnett SM, Colebunders R, *et al*. Disease diagnosis in primary care in Uganda. *BMC Fam Pract* 2014;15:165.
19 Bamiselu OF, Ajayi I, Fawole O, *et al*. Adherence to malaria diagnosis and treatment guidelines among healthcare workers in Ogun State, Nigeria. *BMC Public Health* 2016;16:828.
20 Dalrymple U, Arambepola R, Gething PW, *et al*. How long do rapid diagnostic tests remain positive after anti-malarial treatment? *Malar J* 2018;17.
21 Albertini A, Lee E, Coulibaly SO, *et al*. Malaria rapid diagnostic test transport and storage conditions in Burkina Faso, Senegal, Ethiopia and the Philippines. *Malar J* 2012;11:406.
22 Boadu NY, Amuasi J, Ansong D, *et al*. Challenges with implementing malaria rapid diagnostic tests at primary care facilities in a Ghanaian district: a qualitative study. *Malar J* 2016;15:126.
23 Fernando SD, Ainan S, Premaratne RG, *et al*. Challenges to malaria surveillance following elimination of indigenous transmission: findings from a hospital-based study in rural Sri Lanka. *Int Health* 2015;7:317–23.
24 Druetz T, Fregonese F, Bado A, *et al*. Abolishing fees at health centers in the context of community case management of malaria: what effects on treatment-seeking practices for febrile children in rural Burkina Faso? *PLoS One* 2015;10:e0141306.
25 Ferrer BE, Webster J, Bruce J, *et al*. Integrated community case management and community-based health planning and services: a cross sectional study on the effectiveness of the National implementation for the treatment of malaria, diarrhoea and pneumonia. *Malar J* 2016;15:340.
26 Bawate C, Callender-Carter ST, Nsajju B, *et al*. Factors affecting adherence to national malaria treatment guidelines in management of malaria among public healthcare workers in Kamuli district, Uganda. *Malar J* 2016;15:112.
27 Buregyeya E, Rutebemberwa E, LaRussa P, *et al*. Comparison of the capacity between public and private health facilities to manage under-five children with febrile illnesses in Uganda. *Malar J* 2017;16:183.
28 Macarayan EK, Gage AD, Doubova SV, *et al*. Assessment of quality of primary care with facility surveys: a descriptive analysis in ten low-income and middle-income countries. *Lancet Glob Health* 2018;6:e1176–85.
29 Ladner J, Davis B, Audureau E, *et al*. Treatment-seeking patterns for malaria in pharmacies in five sub-Saharan African countries. *Malar J* 2017;16:353.
30 Manyando C, Njunju EM, Chileshe J, *et al*. Rapid diagnostic tests for malaria and health workers' adherence to test results at health facilities in Zambia. *Malar J* 2014;13:166.
31 Pulford J, Smith I, Mueller I, *et al*. Health worker compliance with a 'test and treat' malaria case management protocol in Papua New Guinea. *PLoS One* 2016;11:e0158780.
32 Galactionova K, Tediosi F, de Savigny D, *et al*. Effective coverage and systems effectiveness for malaria case management in sub-Saharan African countries. *PLoS One* 2015;10:e0127818.
33 Malaria - The Global Fund to Fight AIDS, Tuberculosis and Malaria.
34 Kathirvel S, Tripathy JP, Tun ZM, *et al*. Physicians' compliance with the National Drug Policy on Malaria in a tertiary teaching hospital, India, from 2010 to 2015: a mixed method study. *Trans R Soc Trop Med Hyg* 2017;111:62–70.
35 Hooft AM, Ripp K, Ndenga B, *et al*. Principles, practices and knowledge of clinicians when assessing febrile children: a qualitative study in Kenya. *Malar J* 2017;16:381.