Field Evaluation of Malaria Surveillance System in Sai Yok District, Kanchanaburi Province, Thailand

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Abstract

Evaluation of the malaria surveillance system was conducted in Sai Yok District, Kanchanaburi Province, Thailand. The objective of the study was to describe the surveillance system and assess the system performance in reporting malaria cases. The study applied cross-sectional approach. Key qualitative and quantitative attributes were assessed. Document review on malaria cases treated in Sai Yok Hospital and data collection at Vector Borne Disease Control Unit (VBDU) in 2015 were performed. In-depth interviews with policy makers and health care workers were exercised. Findings showed that sustainability of the surveillance system might be undermined if the Global Fund support would curtail after 2017. There were some discrepancies between number of cases reported by VBDU and those by health facility via the R506 national reporting system. Sensitivity of VBDU reports was slightly higher than the reports by the hospital though the overall sensitivity of the whole district was of acceptable quality. Concerning policy recommendations, a substantial shift of budgetary support from the Global Fund to domestic resources was suggested. Health personnel at the hospital should be more emphasized on the utilization of R506 reporting system. In addition, the R506 reporting system and the VBDU system should be harmonized.

Keywords: malaria, surveillance evaluation, Global Fund, human resources

Introduction

Malaria has been one of the most critical global health problems for years. In 2014, approximately 3.2 billion people were at risk of malaria with 214 million reported cases and 438,000 deaths.[1] In Thailand, there were 32,953 malaria cases with 38 deaths in the same year.[2] The Thai Ministry of Public Health

(MOPH) has introduced a number of initiatives with an aim to halt the progress of malaria infection. One of the most renowned campaigns is 'Malaria Free Thailand by 2024'[3].

Surveillance system is an integral component of infectious disease control. It is clearly presented as one of the main four strategies for malaria elimination program in Thailand[3]. A sound surveillance system should contain reliable and timely dataset that provides epidemiologists and health practitioners a clear insight on the situation in the field[4].

The surveillance system for malaria in Thailand consists of passive case detection and active case detection.[3] Passive case detection mainly functions via the routine national infectious diseases case report, namely 'R506', which has been implemented by the Bureau of Epidemiology (BOE), Department of Disease Control, MOPH. The R506 was introduced in public health facilities.

Active case detection is functioned by the Bureau of Vector Borne Diseases (BVBD) under the Department of Disease Control, and in the upcountry, is performed by the Vector Borne Disease Control Unit (VBDU) under the Office of Disease Prevention and Control. Key sub-activities of the active case detection include: (i) special case finding, (ii) mobile malaria clinic, (iii) mass blood survey, and (iv) case investigation during the survey. The active case finding focuses on 10 border provinces, which are at high risk of malaria spreading.[5]

In addition, MOPH has extended its collaboration on malaria eradiation with the external partners. For domestic collaboration, it has been working closely with Biomedical and Public Health Informatics (BIOPHICS) under the Mahidol University, in establishing a web-based surveillance system, so-called, 'Malaria Online'[6]. The web-based system applied the same case definition and classification as the R506 reporting system. The difference is that Malaria Online encompasses both active and passive case detection with a purpose to obtain timely malaria surveillance data and ultimately to feed those data back for implementation of malaria elimination program[5].

In terms of international collaboration, the most distinct supporting agency is the Global Fund (GF) to Fight AIDS, Tuberculosis and Malaria. Founded in 2002, it is the largest international funding instrument to support prevention and treatment of human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS),

tuberculosis and malaria in many developing countries with high disease burdens amidst limited capacities to address them, including Thailand.[7]

Despite several initiatives introduced to eliminate malaria, a systemic evaluation of the surveillance system was still lacking. Therefore, the objective of this study was to evaluate malaria surveillance system in Thailand using Sai Yok, a border district between Thailand and Myanmar in Kanchanaburi Province, as a case study.

Methods

Study Design

A cross-sectional approach was applied. Both qualitative and quantitative methods were employed.

Study Site

The study was conducted during 2015 in Sai Yok District, including four subdistricts that are covered by VBDU. Sai Yok District was amongst areas with the highest malaria incidence along the Thai-Myanmar border. To be more specific, Sai Yok Hospital was selected as the main study site.

Data Collection Techniques and Participants

In-depth interviews with 27 key informants were performed, including six policy makers, 18 health workers and three information and technology (IT) staff. Narrative analysis was exercised on qualitative attributes. The R506, VBDU reports, laboratory log-books and medical records in all related health facilities were reviewed in order to address quantitative attributes. Descriptive statistics were applied on quantitative data.

Attributes to be Measured

The analysis started with a system description, followed by a scrutiny in each attribute. Qualitative interview data were used to describe the system and address the following attributes: 'public health importance', 'usefulness' and 'stability'. The key informants were asked whether and to what extent they were aware of the surveillance system, including case definition and data flow. The quantitative data captured different aspects of the system, that is, 'sensitivity' (proportion of cases reported to the system to all malaria diagnosed cases), 'positive predictive value' (PPV) (proportion of malaria-diagnosed cases to all reported cases), 'timeliness' of reporting cases (as measured by difference between diagnosis date and data-submitting date, which should not exceed five days until the data reached the

BOE), and 'completeness' (as measured by the completion of key variables entered in the system)[8].

Results

System Description

The flow of data started when the patients visited malaria post (MP), border malaria post (BMP), malaria clinic (MC), and Sai Yok Hospital. The patients were confirmed by either thick film microscopic exam or rapid diagnosis test (RDT). Both negative and positive cases were recorded in a form, called EP1. If the patient's test found positive, more information would be further collected in another form, namely EP3, which included additional variables, such as risk factors and signs and symptoms. The MP, BMP and MC reported VBDU with EP1 and EP3 forms. VBDU reported the same information in paper to Vector Borne Disease Control Centre (VBDC), and then submitted these data to the Office of Disease Prevention and Control Region 5.

In Sai Yok Hospital, the providers directly entered the data into the R506 system, which was further incorporated into Malaria Online. The frequency of data submission from Sai Yok Hospital to Provincial Health Office which then submitted to BOE, and from BOE to Malaria Online took around a week on average. Apart from the formal communication, there was an informal communicating mean between Sai Yok Hospital and VBDU through a weekly telephone call (Figure 1).

Qualitative Attributes

Public health importance

The majority of interviewees underpinned that malaria surveillance system was of critical importance for malaria control in the whole country.

Two thirds of the interviewees flagged that the purposes and objectives of the system were to detect the outbreak, and make the providers understand the trend and situation of malaria. The informants also articulated that they understood and recalled the definition of malaria suspected and malaria confirmed cases very well.

"In my opinion, the malaria surveillance system provides information for malaria situation and timely control when there is an outbreak." – One of health worker interviewees

"Malaria confirmed case is a case that shows positive with lab results" – One of health worker interviewees

Yet, around one third of the interviewees opined that the surveillance for malaria should be given less priority compared to other surveillance systems due to its low prevalence relative to other infectious illnesses. Besides, seven out of eight health workers in Sai Yok Hospital stated that they were not aware of the objectives of the system. Only one interviewee in Sai Yok Hospital who could well describe the purpose of the system was the hospital director.

Usefulness

The usefulness of malaria surveillance program was illustrated in various angles. Of 27 interviewees, 16 mentioned that the surveillance system was beneficial in introducing appropriate control measures. About 11 interviewees highlighted that the surveillance system was helpful in identifying hot spot areas. Around a quarter of the interviewees pointed that the surveillance data were of help in reflecting the providers' performance in malaria control. A few interviewees (~4/27) flagged the value of the system in terms of budget planning and setting research priority.
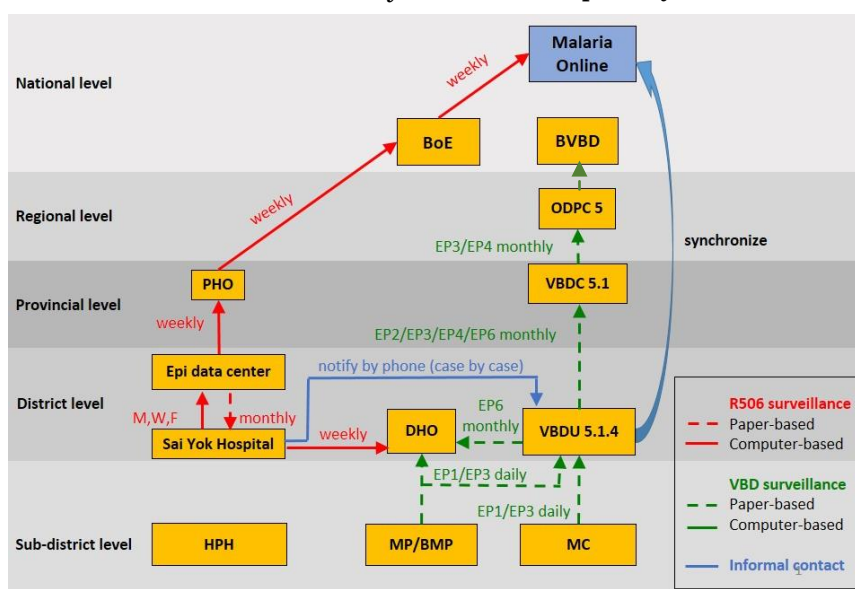

Figure 1. Data flow of malaria surveillance system in Sai Yok District, Kanchanaburi Province, Thailand

Stability

Most health workers raised concern over the stability of the surveillance program. This issue was related to the possibility that GF support would be weaning off. With reference to the 23rd GF Board meeting in 2011, a new eligibility, counterpart financing and prioritization policy was adopted for all funding channels, by taking into account the country income level, disease burden and recent funding history[9]. The GF policy change affected funding opportunities to Thailand, not only for malaria, but also for HIV/AIDS and tuberculosis. Although the burden was high, with a history of recent funding, Thailand was neither eligible to submit a proposal for General nor Targeted Funding Pool (Table 1).

At present, the GF support was earmarked for material (such as computers and tools used for active case detection) and salary costs for health workers. The extent of salary support varied across authorities. BMP and MP might be affected most if GF sponsorship withdrew. This was because all salary costs for BMP and MP staff were subsidized by GF. The reliance on GF support in PHO, VBDC and VBDU was also observed, yet to a lesser extent[10]. Thus, detection and co-ordination function which was the main responsibility of BMP and MP would be undermined by termination of GF funding more severely than other functions (Table 2).

Quantitative Attributes

Sensitivity

In Sai Yok Hospital, a total of 39 malaria cases were identified and reviewed. Eleven cases were found without notification in R506; thus, these missing reports were not submitted to Malaria Online. In VBDU, total 157 malaria cases met case definition for malaria. Amongst these, one was not notified to Malaria Online. Thus, sensitivity of reporting was 71.8% (28/39) in Sai Yok Hospital and 99.4% (156/157) in VBDU.

After combining two data sources (39 cases and 157 cases) and dropping the duplicated cases, a total of 184 cases were identified. Of these 184 cases, 172 were reported to Malaria Online. Hence, the sensitivity of case reporting to Malaria Online over the whole district was approximately 93.5% (172/184) (Figure 2).

Positive predictive value

PPV of the surveillance system was calculated by reviewing EP1 forms in VBDU and medical records in Sai Yok Hospital. It appeared that all 172 cases presented in Malaria Online had evidence of positive laboratory test, reflecting 100% of PPV.

Completeness

Completeness for date of diagnosis, date of investigation and case classification were reviewed in the data entry system. It revealed that all 172 cases had complete information on these variables. This might be due to the 'Must Enter' function in the software which did not allow data submission if these variables were missing.

Timeliness

The R506 system was evaluated for timeliness by measuring lag time between dates of diagnosis and data submission to higher-level health facilities. The median lag time in Sai Yok Hospital was two days (range 0-18 days). The lag time in VBDU was also the same, yet with a much narrower range (median 2 days, range 0-4 days). This corresponded to the fact that about 73% of data from Sai Yok Hospital were submitted to BOE in the recommended period while VBDU demonstrated 100% of timely submission.

Table 1. Profiles of eligibility to the Global Fund support in Thailand

	HIV/AIDS	Tuberculosis	Malaria
Eligibility Criteria			
Income category	UMI	UMI	UMI
Is the country on the OECD-DAC list of ODA recipients?	Yes	NA	NA
What is the disease burden of the country for each component?	High	Severe	Severe
Does the country have a history of recent funding?	Yes	Yes	Yes
General Funding			
Is the country eligible to submit a proposal in the General Funding Pool?	No	No	No
Partial prioritization score (income level and disease burden, the minimum partial score is 3 and the maximum is 12)	NA	7	7
Targeted Funding Pool			
Is the country eligible to submit a proposal in the Targeted Funding pool?	No	No	No

Source: GF Eligibility List (2013)

Acronyms: OECD-DAC = Organisation for Economic Co-operation and Development-Development Assistance Committee,
ODA = Official Development Assistance, UMI = Upper middle income, NA = Not applicable

Table 2. Summary of functions related to malaria surveillance in each organization and the extent of salary support by the Global Fund

Organization	Detection	Response	Co-ordination	Salary supported by the Global Fund
BVBD	Not involved	Data management and logistic support	Coordinate with BIOPHICS in data integration*	None
BOE	Not involved	R506 data management	Coordinate with PHO and ODPC for data collection and distribution*	None
ODPC	Not involved	Logistic support*	Coordinate with VBDC	None
PHO	Not involved	Evaluate malaria situation and logistic support	Receive R506 report from hospitals and submit these data to BOE*	About a quarter of staff (1/4) involved in malaria surveillance
VBDC	Not involved	Surveillance on malaria vectors and chemical resistance	Submit data (EP3 and EP4) of malaria cases to ODPC on a monthly basis*	About 11.2% of staff (11/98) involved in malaria surveillance
VBDU	Case investigation	Mosquito spraying	Submit data (EP2, EP3, EP4 and EP6) of malaria cases to VBDC and receive malaria data from BMP, MP and hospitals*	About a quarter of staff (2/8) involved in malaria surveillance
MC	Screen patients with suspected symptoms and perform blood test for malaria*	Provide treatment and follow cases	Submit data (EP1 and EP3) of malaria cases to VBDU on a daily basis	None
Hospital	Screen patients with suspected symptoms and perform blood test for malaria	Provide treatment and follow cases	Collaborate with VBDU for information sharing and dead case investigation*	None
MP and BMP	Screen patients with suspected symptoms and perform blood test for malaria (with test kit)*	Provide basic treatment and refer patients to higher level health facilities	Submit data of malaria cases (EP1 and EP3) to VBDU and District Health Office (DHO)	All staff (5/5) in MP and BMP had their salary supported by GF.
Health center	Screen patients with suspected symptoms and refer them to receive treatment at higher level facilities*	Not involved	Not involved	None
Private clinic	Screen patients with suspected symptoms and refer them to receive treatment at higher level facilities*	Not involved	Not involved	None
BIOPHICS	Not involved	Not involved	Merge and analyse data from BVDB and BOE, then present the data on the webpage*	None
DHO	Not involved	Not involved	Train health volunteers and support the function of MP and BMP*	None

Note: *Main function

Acronyms: BVBD = Bureau of Vector Borne Diseases, BOE = Bureau of Epidemiology, ODPC = Office of Disease Prevention and Control, PHO = Public Health Office, VBDC = Vector Borne Disease Control Center, VBDU = Vector Borne Disease Control Unit, MC = Malaria clinic, MP = Malaria post, BMP = Border malaria post, DHO = District Health Office

Discussion

Overall, this study was amongst the first few studies in Southeast Asia that focused on malaria surveillance. Actually, in the sphere of international literature, there were some studies on malaria surveillance evaluation. However, most of which were conducted outside Southeast Asia, like Chehab et al from Qatar[11] and Ibrahim et al from Nigeria[12]. In addition, the study by Chehab et al limited the evaluation only on quantitative attributes whereas qualitative attributes were still missing[11].
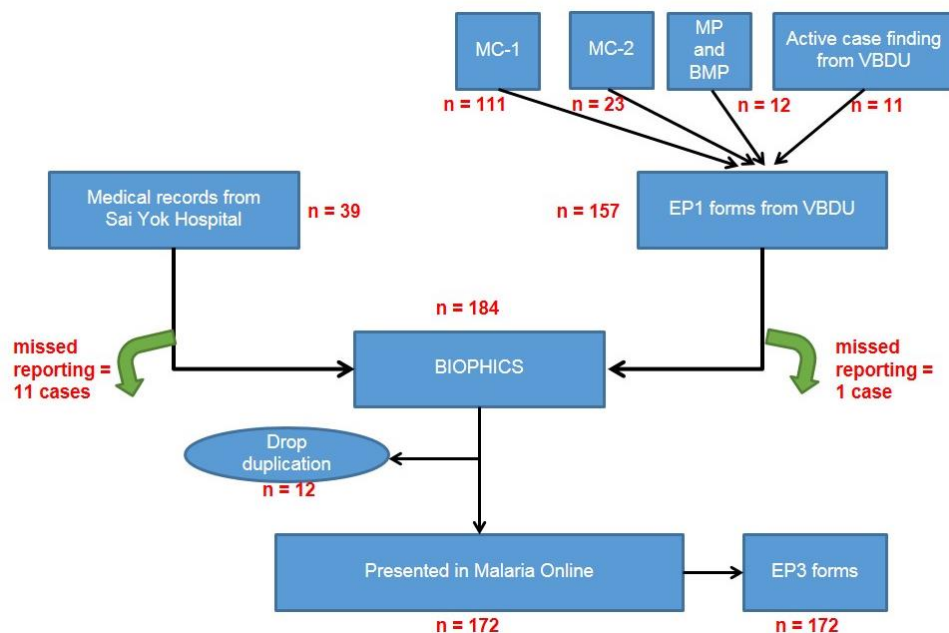
Figure 2. Sensitivity of malaria surveillance system in Sai Yok District, Kanchanaburi Province, Thailand, 2015

One of the few studies on malaria evaluation in Southeast Asia was a research by Rae et al from Myanmar. However, Rae et al paid much attention on the process of diagnosis and treatment over the surveillance system per se[13]. Therefore, this study was probably the first study in Southeast Asia that delved into both qualitative and quantitative attributes of the malaria surveillance system. Sai Yok District was used as a case study for evaluation.

It was found that the system involved a vast range of stakeholders, from frontline health posts (for example, MC, MP and BMP) to well-established health facilities (like Sai Yok Hospital, VBDU and VBDC). There were two strands of data flow: first from VBDU which receives data from MC, MP and BMP, and second from Sai Yok Hospital.

Some discrepancies between these two strands were noticed. The data flow in the VBDU strand was still in a paper-based form (though these data would be keyed into Malaria Online later) while that in Sai Yok Hospital was in electronic form. Though, at the time of study, the sensitivity and timeliness of data reporting in the VBDU strand was still acceptable (99.4% sensitivity with 2-day lag time), a heavy reliance on the paper-based reporting system might pose a risk of reporting delay and data loss. Thus, data flow from both strands should be harmonized.

High sensitivity and timeliness of the surveillance system in VBDU could be explained by the fact that the main responsibility of VBDU and its affiliated health posts was to provide timely case detection. This was evidenced by the observation that almost all health workers working there were quite aware of

this responsibility. Besides, the functions in VBDU encompassed various components, including diagnosis, treatment and reporting like a one-stop service unit. By contrast, the main function of Sai Yok Hospital was to provide appropriate treatment rather than perform active case finding. Accordingly, reporting data to R506 was done in a passive manner. This idea coincided with the field observation which demonstrated that most health workers in the hospital did not show a clear understanding of the purpose and objectives of the surveillance system. This factor might help explain lower sensitivity of malaria report in Sai Yok Hospital relative to that of VBDU. Nevertheless, from a macro-perspective, the quantitative attributes of the surveillance system over the whole district (sensitivity, PPV, timeliness and completeness) were of acceptable quality.

Another worth-discussing point was while the interviewees mentioned the usefulness of the system in diverse angles, most of them conspicuously raised concerned over the system stability. This issue was directly linked with the tendency that GF support might be curbed. Similar story was flagged in a study by Patcharanarumol et al, underlining that the curtailment of GF sponsorship might undermine HIV/AIDS prevention programs in Thailand, especially for the prevention programs exercised by civic groups and non-government organizations[7]. Patcharanarumol et al also proposed a pooled funding mechanism that mobilized budget mainly from domestic sources[7]. This idea originated from the fact that Thailand has always relied on domestic resources to fight HIV/AIDS for years while in some countries, like Bhutan, this proposal might not be

able to operationalize easily as around 80% of the fund to tackle HIV/AIDS and malaria were from international donors[14]. The same idea might apply to the case of malaria surveillance as well. Further study on this issue was recommended.

There remained some limitations in this study. First, a case study with single province made it difficult to generalize the findings to other settings[15]. Second, this study did not explore the functions of private health facilities or non-governmental affiliated facilities. Last but not least, the situation of GF support to Thailand (and other countries in the Southeast Asia region) is quite dynamic and at the time of the study, there was a public discussion about whether there were other mechanisms that could secure GF support without breaching the GF eligibility criteria (for instance receiving financial support through a regional proposal)[16]. Therefore, information from the interviews might be obsolete when this article was publicly launched.

Conclusion

This study illuminated the surveillance system for malaria in Sai Yok District. There were two strands of data flow: from VBDU which received data from MC, MP and BMP, and from Sai Yok Hospital. The data flow in the VBDU strand was still in a paper-based form, though these data would be keyed into Malaria Online later. By contrast, Sai Yok Hospital employed electronic data-entering form for the whole system. Both strands were merged together and the final data were presented in Malaria Online. Sensitivity, PPV, timeliness and completeness of the reporting system from both Sai Yok Hospital and VBDU were of acceptable quality. Most participants recognized the usefulness and importance of the surveillance system. However, the main concern was centered on system stability given the withdrawal of GF support. If the GF financial assistance was to curtail, the detection functions performed by MP and BMP would be affected most.

Recommendations for Public Health Actions

Concerning policy recommendations, there should be a substantial shift of budgetary support from GF to domestic resources. Health personnel at the hospital should more emphasize on submission of malaria data to the R506. In addition, the R506 reporting system and the VBDU system should be harmonized.

Acknowledgement

Suggested Citation

References

1. World Health Organization. World malaria report 2015. Geneva: World Health Organization; 2015.

2. Thailand. Bureau of Vector Borne Diseases. Department of Disease Control. Ministry of Public Health. Malaria program review. Nonthaburi: Department of Disease Control; 2015.

3. Thailand. Bureau of Vector Borne Diseases. Department of Disease Control. Ministry of Public Health. Programmatic review of the national malaria programme in Thailand. Nonthaburi: Department of Disease Control; 2015.

4. Bloland P, Williams H. Malaria control during mass population movements and natural disasters. Washington DC: National Academies Press; 2002.

5. Thailand. Bureau of Vector Borne Diseases. Department of Disease Control. Ministry of Public Health. National monitoring and evaluation plan for malaria control and elimination in Thailand. Nonthaburi: Department of Disease Control; 2016.

6. Faculty of Tropical Medicine. BIOPHICS history. 2008 [cited 2019 Apr 12]. <http://www.biophics.org/index.php/about-us/biophics-history#HISTORY>.

7. Patcharanarumol W, Thammatacharee N, Kittidilokkul S, Topothai T, Thaichinda C, Suphanchaimat R, et al. Thailand's HIV/AIDS program after weaning-off the global fund's support. BMC Public Health. 2013;13(1008):1471-2458.

8. German RR, Lee LM, Horan JM, Milstein RL, Pertowski CA, Waller MN; Guidelines Working Group Centers for Disease Control and Prevention (CDC). Updated guidelines for evaluating public health surveillance systems: recommendations from the Guidelines

Working Group. MMWR Recomm Rep. 2001 Jul 27;50(RR-13):1-35; quiz CE1-7.

9. The Global Fund. Policy on eligibility criteria, counterpart financing requirements, and prioritization of proposals for funding from the Global Fund. Geneva: The Global Fund; 2011.

10. Thailand. Bureau of Vector Borne Diseases. Department of Disease Control. Ministry of Public Health. A guideline for partnership for containment of artemisinin resistance and moving towards the elimination of *Plasmodium* in Thailand. Nonthaburi: Department of Disease Control; 2014.

11. Chehab MA, Bala MO, Al-Dahshan A, Selim NA, Al-Romaihi HE, Al-Thani M, et al. Evaluation of the completeness and timeliness of national malaria surveillance system in Qatar, 2016. Cureus. 2018;10(6):e2851-e.

12. Ibrahim BS, Abubakar AA, Ummulkhulthum AB, Nguku PM. Evaluation of the malaria surveillance system in Kaduna State, Nigeria 2016. Online Journal of Public Health Informatics. 2017;9(1):e177.

13. Rae JD, Nosten S, Proux S, Myint Thu A, Cho WC, Paw K, et al. The role of monitoring and evaluation to ensure functional access to community-based early diagnosis and treatment in a malaria elimination programme in Eastern Myanmar. Malar J. 2019 Feb 22;18(1):50.

14. Wangdi K, Banwell C, Gatton ML, Kelly GC, Namgay R, Clements AC. Malaria burden and costs of intensified control in Bhutan, 2006-14: an observational study and situation analysis. Lancet Glob Health. 2016 May;4(5):e336-43.

15. Yin RK. Case study research: design and methods. 3rd ed. California: Sage Publications, Inc; 2003.

16. Malaria Consortium. Partnership for containment of artemisinin resistance and moving towards the elimination of *Plasmodium* in Thailand. 2016 [cited 2019 May 1].
<https://www.malariaconsortium.org/what-we-do/projects/17/partnership-for-containment-of-artemisinin-resistance-and-moving-towards-the-elimination-of-plasmodium-in-thailand>.