

Evidence review group on border malaria

Meeting report, 10–11 May 2018
World Health Organization, Geneva, Switzerland

Executive summary

Border malaria is defined as malaria transmission or potential for transmission that takes place across or along borders between countries sharing a land border. Border malaria can extend up through the adjacent administrative areas along the international border, or up to a specified distance from an international border. Countries nearing elimination often find their last few cases occurring along international borders with countries that have not achieved substantial reductions in malaria transmission. Recommended by the Malaria Policy Advisory Group, an Evidence Review Group (ERG) on border malaria was formed to review evidence on characteristics of malaria transmission in border areas, factors that contribute to transmission and current interventions to reduce border malaria. Five case studies on border malaria and a summary of literature and grey literature were reviewed. Experiences and lessons from other communicable diseases with a risk of cross-border transmission were also reviewed.

Summary of conclusions and recommendations

1. Many countries nearing elimination refer to cross-border malaria issues as significant challenges. “Cross-border” malaria problems may comprise two related but distinct issues: movement of people infected with malaria parasites across international borders, including airports and sea ports, and malaria transmission that crosses or occurs along international land boundaries. The subject of this ERG is the latter situation.
2. “Border malaria” is defined as malaria transmission or potential for transmission that takes place across or along borders between countries sharing a land border. Border malaria can extend up through the adjacent administrative areas along the international border, or up to a specified distance from an international border. Frequently, border malaria can be considered a transmission focus that crosses the international border. Border malaria may also occur due to limited or no access to malaria prevention, diagnosis and treatment interventions and suboptimal surveillance response as a result of the remoteness and/or political complexity of border areas. “Transnational malaria” is defined as the importation of malaria parasites across international borders, which may include airports and sea ports. Normally, transnational malaria does not involve the border area *per se*.
3. Border malaria is a complex and multi-faceted issue. Border malaria can occur whether or not there is a differential in transmission between countries. Frequently, countries nearing elimination often find their last few cases occurring along international borders with countries that have not achieved elimination and sustain malaria transmission because control and prevention activities are not equal or optimized throughout the focus they share. In addition, transmission persisting along international borders could be due to other reasons, such as lack of access to malaria prevention, diagnosis and treatment

interventions, and suboptimal surveillance response as a result of the remoteness and/or political complexity of border areas.

4. There is not a one-size-fits-all approach to address border malaria. Multiple factors, including political unrest, difference of social and economic development, weak surveillance and response systems, insufficient access to health service, and differences in national malaria policies, treatment-seeking behaviours and other factors can contribute to malaria transmission in border areas.
5. Because many eliminating countries find their last cases appearing along international borders, countries should consider the problem of malaria along international borders early in order to shorten the long tail of elimination. More resources should be directed to border areas to ensure that prevention, diagnosis, treatment, surveillance and response are of high quality. Border malaria should not be recognized as only a technical issue: it is also a political, social and economic development issue.
6. Bordering countries should conduct joint mapping of health services and risk assessments to inform responses best-suited to the situation and to optimize activities. Joint mapping and risk assessments should cover available health services, local ecology, resources, high-risk areas/populations, movement routes and timing, and health care-seeking behaviour, among other factors. Response plans should include information-sharing and coordination, access to malaria prevention, diagnosis and treatment on both sides of the border, and coordinated vector-control activities to address the mosquito population.
7. Informal data sharing and coordination at the border district level is efficient and effective. When a national agreement is necessary for cross-border collaboration, efforts should be made to reduce the administrative procedures so that activities in border areas can be implemented efficiently. The WHO should explore new modalities for scaling up cross-border coordination and collaboration with neighbouring countries in order to treat these areas holistically and fairly. The concept of “Special Intervention Zone”, developed for onchocerciasis elimination, should be considered.

1. Background

Border or cross-border malaria is a frequently cited challenge to malaria elimination. At the first Global Forum of malaria-eliminating countries, 15 of the 20 E-2020 countries^{1,2} in attendance identified border or cross-border malaria as a major issue in achieving elimination. Cross-border malaria problems may comprise two related but distinct issues: movement of people infected with malaria parasites across international borders including airports and sea ports, and malaria transmission that occurs along and crosses international boundaries. The subject of this ERG is the latter situation. Countries nearing elimination often find their last few cases occurring along international borders with countries that have not achieved substantial reductions in malaria transmission. In the early 1960s, uncontrolled land borders were recognized as the greatest threat to the re-establishment of malaria.³ Because border malaria generally cannot be solved unilaterally, functional border coordination, where relevant, is one of the prerequisites for eliminating malaria and preventing re-establishment of malaria

¹ World Health Organization, 2016. Eliminating malaria.

² Malaria elimination: report from the inaugural global forum of countries with potential to eliminate malaria by 2020. Weekly Epidemiological Record, 2017

³ World Health Organization, 1967. Prevention of the re-introduction of malaria – report of a WHO meeting.

transmission, according to WHO criteria for certification of malaria elimination.⁴ The significance of malaria along borders is reflected in the growing number of cross-country collaborations to mobilize specific resources to reduce malaria in neighbouring countries where migrants originate, mount coordinated efforts to control malaria at borders and enhance surveillance among migrants or local residents at borders.⁵

Definitions and reason for focus on border malaria

“Cross-border malaria” refers to malaria transmission and cases that cross international boundaries. There are two types of cross-border malaria: transnational and border malaria.

“Transnational malaria” refers to imported cases of malaria that cross a border or enter a country through air or sea ports, but do not necessarily affect transmission within the border area *per se*. Transnational malaria can originate from any malaria endemic country and can be received by any malaria-endemic or non-endemic country. The countries of origin and destination of the infection in transnational malaria may or may not be adjacent, and the infection may be received in any location of the recipient country. These malaria infections may or may not generate onward transmission.

“Border malaria” is malaria transmission or potential for transmission that takes place across or along borders between countries sharing a land border. Border malaria can extend up through the adjacent administrative areas along the international border, or up to a specified distance from an international border. Border malaria is often a malaria transmission focus that crosses international borders but it may also occur due to limited or no access to malaria prevention, diagnosis and treatment interventions and suboptimal surveillance response as a result of the remoteness and/or political complexity of border areas.

Border malaria was the subject of this ERG because of numerous important features, many of which relate specifically to countries seeking to eliminate malaria or remain malaria-free. A country’s border areas may include diverse features that both facilitate and require specific attention, including:

- Contiguous areas often share a common ecology, related human populations, and related malaria parasites and vectors.
- Border areas tend to have the least-developed health systems of the nation.
- A substantial health service system and malaria transmission gradient may exist between the adjacent areas across a border.
- As a country seeks elimination, the last remaining infection foci often occur along international borders, suggesting that countries should address border malaria early in their elimination efforts.
- Local cross-border engagement for enhanced communication, data sharing, and coordination of malaria interventions (such as common timing of vector-control activities and common policies for malaria case management) may lead to substantial impact against malaria.

⁴ World Health Organization, 2017. A framework for malaria elimination.

⁵ Lover AA, Harvard KE, Lindawson AE, Smith Gueye C, Shretta R, Gosling R, et al. (2017) Regional initiatives for malaria elimination: Building and maintaining partnerships. PLoS Medicine, 14: e1002401

Despite many countries pointing to border malaria as a hindrance to achieving elimination or maintaining malaria-free status, there has been no clear definition of the problem or understanding of the various issues underpinning border malaria. In general, the term “border malaria” has been used to refer to malaria transmission in border areas as well as malaria imported across international borders by travellers, migrants and refugees; however, the epidemiological characteristics of these situations may differ significantly. The current WHO definition of cross-border malaria doesn’t clearly define the problem of border malaria. To characterize the problem of border malaria and assess its implications for malaria control, elimination and prevention of re-establishment, a working group meeting, initiated by Barcelona Institute for Global Health (ISGlobal) and in collaboration with the WHO Global Malaria Programme, was held 9–10 August 2017 in Geneva, Switzerland. Building on a literature review and a plenary discussion, a definition of border malaria was proposed as “malaria transmission or potential for transmission that takes place across adjacent administrative areas that share an international border (or lie at a specified distance from an international border)”. Border malaria differs from “transnational malaria”, which is defined as imported cases of malaria that cross a border or enter a country, but do not affect transmission within the border area *per se*. Border malaria appears to occur because the contiguous areas share a common ecology, related human populations and related malaria parasites and vectors; accordingly, there is frequent mixing of people, parasites and vectors. In effect, border malaria often occurs when a transmission focus crosses an international border. The relevance of border malaria seems more pronounced when there is a transmission differential across the border due to a gradient in receptivity or intervention coverage. Border malaria may also occur along international borders where access to malaria prevention, diagnosis and treatment interventions is limited and the health and surveillance response system is weak, due to remoteness and political complexity of border areas.

Recommended by the Malaria Policy Advisory Group, an ERG on border malaria was formed to answer key questions related to border malaria and to make recommendations to support countries affected by border malaria in achieving their malaria goals. Five case studies were prepared in order to characterize border malaria and understand factors that contribute to transmission at borders. Literature and grey literature related to border malaria, based on the definition proposed by the working group, were reviewed.

2. Introduction and declarations of interest

The ERG met 10–11 May 2018 to review five case studies and literature on border malaria. A list of participants is provided in Annex 1. All ERG members attended the meeting. Organizations invited as observers were the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM), the International Organization for Migration (IOM) and the University of California, San Francisco (UCSF). The meeting agenda is provided in Annex 2.

All ERG members submitted a declaration of interest that was assessed by the Malaria Elimination Unit of the Global Malaria Programme at the WHO. No ERG members were deemed to have conflicts of interest related to the topics for discussion during the meeting.

3. Objectives of the ERG

- To review published and grey literature on border malaria and to summarize the factors that might influence malaria transmission in border areas.

- To review and comment on case studies and to make specific recommendations on mitigating different factors that hinder the progression of malaria elimination at borders.
- To evaluate the effectiveness of current tools or interventions targeting border malaria.
- To draw evidence from other global/eradication initiatives where cross-border risks have played an important role in disease transmission (polio, measles, Guinea worm, lymphatic filariasis/onchocerciasis).
- To define a research agenda for border malaria and an action plan for the next two to three years.

4. Process

The Malaria Elimination Unit of the GMP/WHO led the preparation and coordination of five case studies on border malaria, with significant input from regional offices, national malaria programmes and partners. The five borders selected for case studies, their authors and their affiliations were:

- Namibia and Angola – Dr Regina Rabinovich, Barcelona Institute for Global Health (ISGlobal), Spain and Rebecca J. Vander Meulen, J.C. Flowers Foundation, United States of America (USA)
- China and Myanmar – Dr Li Xiao Hong, WHO Global Malaria Programme, Switzerland
- Saudi Arabia and Yemen – Dr Robert W Snow, KEMRI-Wellcome Trust Research Programme, Kenya
- Haiti and Dominican Republic – Dr Blanca Escribano, WHO Regional Office for the Americas, Pan American Health Organization, USA
- Bhutan and India – Dr Tashi Tobgay, Khesar Gyalpo University of Medical Sciences, Bhutan

Dr Matiana Gonzalez-Silva of ISGlobal prepared a literature review on border malaria. The Malaria Eradication Science Alliance (MESA) did a review of ongoing and past related research projects dealing with issues relevant to border malaria.

The five case studies, together with literature review on border malaria, were shared with ERG members prior to the meeting, and were presented and discussed in plenary during the meeting. Dr Mufti Zubair Wadood, Outbreak Preparedness & Response, WHO and Dr Moses Katarwa, Carter Center, United States of America, presented their experiences in polio and neglected tropical diseases with reference to onchocerciasis elimination, respectively, related to border issues. The meeting lasted two days. On Day 2, ERG members and participants were split into three working groups to address questions related to: 1) improving the definition of border malaria; 2) interventions for border malaria; and 3) information-sharing and coordination. Rapporteurs of the working groups presented each group's findings to the entire group for further discussion and consensus-building.

The meeting report was compiled by the Elimination Unit (EI), GMP, based on the meeting pre-reads, presentations and discussions held during the ERG meeting. All ERG members reviewed the report and provided further input for consideration in finalizing the report.

5. Review of the evidence

5.1 Definition of border malaria

Current WHO terminology related to border malaria was reviewed. Border malaria was recently proposed as “malaria transmission or potential for transmission that takes place across adjacent administrative areas that share an international border (or lie at a specified distance from an international border)”. This differs from “transnational malaria”, defined as imported cases of malaria that cross a border or enter a country, but do not affect transmission within the border area *per se*. Transnational malaria can originate from any malaria endemic country and can be received by any areas within the recipient country. In contrast, border malaria is local transmission (or potential for transmission) that occurs across or along an international land border shared by two neighbouring countries. Frequently, border malaria is a malaria transmission focus that crosses international borders.

In eliminating countries, transmission may persist in border areas due to disparities between eliminating and higher-burden countries in the control, prevention and treatment of malaria, or limited access to these interventions in remote border regions. Border malaria may occur because the contiguous areas share a common ecology, related human populations, and related malaria parasites and vectors; accordingly, there is frequent mixing of people, parasites and vectors. The relevance of border malaria appears more pronounced when there is a transmission differential across the border due to a gradient in receptivity or intervention coverage.

While similar situations may occur within countries when provinces share borders, the issues of addressing malaria along domestic borders was not within the scope of the ERG.

5.1.1 Conclusions

- Border malaria is frequently related to the dynamics of transmission across an international boundary. As such, the usual control and prevention measures adopted by a country alone are not sufficient to progress toward reducing and interrupting transmission. Border malaria may also occur due to the remoteness or political complexity of the border area, which may contribute to limited or no access to malaria prevention, diagnosis and treatment and suboptimal surveillance response.
- Because many eliminating countries find their last cases appearing along international borders, countries should consider the problem of border malaria early in their elimination agenda to help shorten the long tail of elimination.
- Border malaria can occur whether or not there is a differential in transmission between countries. Eliminating countries identify border malaria as a significant problem because transmission along international borders with higher-burden countries persists when control and prevention activities are not equal or synchronized throughout the focus.
- Many countries experience onward transmission from imported cases due to transnational malaria. Transnational malaria may be associated with significant risk of transmission, but the interventions that are used to address border malaria and transnational malaria will be different. For example, preventing onward transmission from cases of transnational malaria, which by definition occurs in the interior of the country, does not require coordination with the sending country.

- Both border malaria and transnational malaria may overlap with other challenging situations for elimination, such as hard-to-reach populations, refugees and migrants, and mobile populations.

5.1.2 Recommendations

- A clear definition of border malaria, as provided in this document for wider review and approval, should be included in the WHO malaria terminology to facilitate increased attention to malaria in border areas and facilitate malaria elimination and prevention of re-establishment.
- Identify drivers of transmission that may increase the intensity of transmission in the border area.
- Provide a matrix or checklist for countries to help them assess how significant each factor is for transmission along their borders and to define the best-suited interventions.

5.2 Border malaria: Literature review and map of related projects

The review included both published literature and grey literature, including WHO meeting reports, minutes from working groups and presentations at scientific conferences. The review noted that malaria transmission in border areas affects both migrants⁶ and residents of border areas. It was noted that mosquitoes flying across the border represent part of the problem of cross-border malaria, but that the most important factor triggering transmission at border areas is constant and intense population movement across the borders, which is commonly seen in all border areas studied in this review. The presentation is summarized below.

Population movement across a border could be legal or illegal, happening at official or unofficial crossing points. Sometimes borders are not recognized by local border residents. Population movement across borders is often short-term and cyclical, without implications on long-standing change in residence. It is closely related to ethnic, family and cultural links.

Potential contributors to border malaria are numerous. In general, border areas are remote, less developed, sometimes more forested and likely to have weak health systems. The level of surveillance is low and insufficient to cover mobile and migrant populations, nomadic and indigenous populations, or minorities who normally gather or reside along borders. Treatment-seeking behaviour of underserved populations at borders – such as self-medication and poor quality of treatment with counterfeit and substandard medicines – may contribute to the development of drug resistance. Population movement across borders to seek malaria treatment for economic, security or access reasons is commonly seen and likely contributes to transmission at borders. Differences in national malaria policies (such as for primaquine) can lead to incomplete adherence, and risks associated with occupational activities such as farming, mining, logging or smuggling contribute to border transmission. Civil unrest can foster the settlement of refugees or internal-displaced populations coming from malaria endemic areas at borders. Unstable political and social environments at borders can hamper the deployment

⁶ The International Organization for Migration defines a migrant as any person who is moving or has moved across an international border or within a State away from his/her habitual place of residence, regardless of (1) the person's legal status; (2) whether the movement is voluntary or involuntary; (3) what the causes for the movement are; or (4) what the length of the stay is. For the purposes of this meeting report, migrant refers to people who cross international borders by land, sea or air.

of interventions. The illegal status of some populations along borders makes it difficult to access prevention, diagnosis and treatment. Sometimes cultural differences and language barriers on both sides of the border complicate diagnosis, follow-up of treatment and implementation of prevention activities. The heterogeneity of malaria prevalence and the unknown malaria reservoir complicate elimination in border areas.

Risk groups include male travellers – mostly traders, forest workers, military men, local farmers and rural migrants who have myriad economic pursuits across the various border settings. They also include inhabitants of villages near borders, indigenous populations and others.

The interventions used for malaria control/elimination at border areas include: training community health workers or mobile workers to provide malaria diagnosis and treatment; enhanced surveillance; enhanced access to prevention, diagnosis and treatment for populations at risk; vector control via border posts or other measures; setting up border screening posts for enhancement of access to malaria service; coordination or synchronization of activities particularly on vector control; enhanced social and behaviour-change communication and health education; capacity building on health infrastructures at borders; reactive case detection; and mass drug administration. As pointed out by the MESA Track database review, no evaluations on the effectiveness of proposed interventions for reducing malaria transmission along international borders have been conducted.

Reported best practices include the exchange of information and sharing knowledge through either formal memorandum of understandings or informal local collaborations between border districts; technical collaboration and training of specialized staff; specific cross-border agreements; free crossing for health professionals involved in malaria control and elimination campaigns and no custom duties for malaria commodities; regional collaborations (Greater Mekong Subregion [GMS], the E8 in southern Africa); and multipronged strategies on both sides.

Knowledge gaps and research agenda include tools to distinguish between imported and locally transmitted malaria; surveillance methods that can target mobile populations; tools to understand the role of low-density parasitaemia and parasite reservoir in malaria transmission; models to inform the deployment of targeted interventions; and strategies along borders. There is a lack of evidence on the contribution of population movement to border malaria, including how to measure and classify different types of movement. There is a lack of data/evidence on the effectiveness of current interventions. Seeking ways to close the gap between published political agreements and concrete implementation is important.

Conclusions

- No single intervention will work in all locations, and an integrated approach is needed to tackle border malaria.
- Multiple stakeholders should be engaged in working toward elimination of border malaria. These include government agencies, United Nations agencies and international organizations, employment agencies, donors, religious organizations, international non-governmental organizations (NGOs), local NGOs, and the mobile and border populations themselves.
- When multiple parties are involved in providing malaria service in border areas, coordination among these parties by a neutral party who has mandate and experience

(including national health workers, NGOs and regional initiatives) becomes critical in that all information should reach the National Malaria Control Programme (NMCP) to improve surveillance and to mount a rapid response. This neutral party should have the capacity to foster successful cross-border collaboration, given the complexity of border issues. This review noted that the WHO has a critical role in providing support to institutionalize agreements between countries, to build capacity, to establish mechanisms of information exchange and response, and to facilitate harmonization of guidelines where relevant.

- Collaboration at the local level between adjacent administrative units across the border is more relevant in addressing border malaria than national-level activities. That is, national approval may be useful in facilitating the work, but the local communication and collaboration will be critical to achieving progress.
- Malaria prevention and control in border areas should be incorporated into social and economic planning.
- Emergency communication during outbreaks in border areas is critical.
- Experiences and lessons learned from countries where malaria has already been eliminated will be informative to countries facing border malaria issues.

5.3 Case studies

5.3.1 Namibia and Angola

The border area in this case study is covered in the original Trans-Kunene Malaria Initiative (TKMI) agreement: Kunene, Omusati and Ohangwena regions in Namibia, and Namibe and Cunene provinces in Angola. This area is largely rural, with poor road access and rugged terrain. The Namibian War of Independence and the Angolan Civil War have impeded development in this area for decades and continue to threaten health today. The general economic situation in this border area is poor, but residents on the Cuvelai Basin of Angola side are more so than the neighbouring Namibian Cuvelai residents, as indicated by the housing material. The investment in health systems in Namibia is twice that of Angola. Both the community of the Oshiwambo tribe and the Himba community lie on both sides of the border. Population movement across the border is frequent.

The primary vector for malaria in Namibia remains *Anopheles arabiensis*, while in Angola, five anopheline species responsible for malaria transmission – including *An. gambiae*, *An. arabiensis* and *P. falciparum* – account for over 97% and 87% of all reported cases in Angola and Namibia, respectively. The transmission difference between two sides is large, with incidences in Angola and Namibia being 185–251 per 1000 people and 0.9–57 per 1000 people, respectively. The case study noted that it is difficult to classify cases as imported or indigenous based only on travel history. Data from genotyping might help with identifying parasite origin and flow. The two countries adopted similar policies on long-lasting insecticidal net (LLIN) distributions and used indoor residual spraying (IRS) for vector control; public sectors provide free diagnosis. Artemisinin-based combination therapies (ACTs) are the only first-line treatments used in Namibia, but in Angola, a single dose of primaquine is added, as gametocidal medicine for *P. falciparum*.

Implementation of the TKMI includes the distribution of free LLIN (one per sleeping space), and regular household visits by trained community volunteers who monitor the usage and

conditions of nets and who provide malaria information and guidance to households. Namibia is part of the Elimination 8 (E8) in southern Africa. A primary contribution of the E8 to the TKMI region has been the sponsorship of two distinct projects – one E8-wide initiative focusing on increasing access to testing and treatment via setting up malaria border posts and surveillance units at strategic locations on the shared borders of the eight countries, and one specific to this border, focused on reducing the sources of infection. However, given the length (1427 km) of the largely porous border, these additional facilities (either border malaria posts or new health facilities) are still too far for many Angolans and Namibians to reach easily and are likely insufficient to close the gap of access to health care in this border area.

5.3.2 China and Myanmar

The border area in this case study refers to 19 border counties in Yunnan Province in China and five special regions in Myanmar. The border, defined in 1961, is porous without any natural barriers and is about 2000 km long. The terrain is largely mountainous, but the ecological environment is complex due to the wide range of elevations (from 30 metres to several kilometres). Within China, Yunnan lags behind other provinces in social and economic development – gross domestic product (GDP) per capita ranked 29th out of 31 provinces. The so-called five special regions in Kachin and Shan states of Myanmar lack social and economic development, are politically unstable due to the country's ongoing civil war, and are currently under the control of armed ethnic groups. The border area on the Myanmar side is sometimes the settlement for internal displaced populations to flee the war. Many minorities reside in this border area. Some ethnic groups reside on both sides of the border, sharing a culture, language and religion. Population movements across the border are estimated at 5 million person-times /year, and 1.5 million short-term migrants from both sides cross frequently (2005).

Malaria epidemiology on this border is complex due to the multiple malaria vectors – *An. minimus* is a primary vector and *P. vivax* has been the major species locally transmitted since 2013. The differential of transmission between the two sides of the border was significant, with the annual parasite index (API) in 19 counties and the five special regions being 0.9/10 000 and 71.3/10 000, respectively (2013). Most of the imported cases in Yunnan came from the five special regions. The health system and surveillance in Yunnan, including in its border area, are strong after years of development. The implementation of the “1-3-7” surveillance and response strategy for malaria elimination in Yunnan ensures that every case is timely detected and responded to. In the border area of Myanmar, the ethnic health organizations and Health Poverty Action, a United Kingdom of Great Britain and Northern Ireland-funded NGO, is providing malaria services and implementing activities. Yunnan recorded zero indigenous cases in 2017 against all the complex factors presented in this study. The five special regions achieved more than 80% reduction of malaria burden, highlighting the success of tackling malaria in this border area.

Malaria-elimination strategies on the Yunnan border emphasize the importance of capacity building in local health facilities in border counties and border townships, and of quality of surveillance. The reduction of malaria burden on the Myanmar border promoted malaria elimination in Yunnan. From the case study, a community-based volunteer network that provided diagnosis and treatment to both residents in the five special regions and to Chinese migrant workers seemed an effective way to increase access to malaria services in the border area in Myanmar, where access to health care is suboptimal. Border collaboration activities, including joint vector control, joint health education, shared surveillance information at the

local (county) level and joint response to outbreak, significantly reduced incidence. This case study also pointed out that transmission on one side of the border seemed to have a linear relationship on the other side. Increasing distance from the border was associated with declining malaria transmission. It was also reported that one community spans two countries – one half reported no transmission and the other reported ongoing transmission. This will pose a challenge for certification.

5.3.3 Saudi Arabia and Yemen

In Saudi Arabia, wealth generated by oil revenue has been channelled by the government to increase the quality of life of most Saudis, including through urbanization, education and improved health care systems since the 1970s. However, economic investment in the southwestern regions of the country did not significantly start until after 2000 due to uncertainty about the border area with Yemen. The border, defined in 2000, measures 1800 km. People living along the border share a common ancestry and malaria ecology.

This border area belongs to the Afro-Tropical malaria ecology, where hypo-endemic *P. falciparum* transmission was a historical feature and transmission was predominately maintained by *An. arabiensis*. Very focal malaria transmission in Saudi Arabia is now constrained to a narrow margin in the southwest region of the country bordering Yemen. Population movement across the border in both directions is common among families. Economic development spurred population movement from Yemen across the border for business reasons and for better access to malaria service. From 2015 to 2017, 32% of all imported infections were of Yemeni origin. Along the border, vector control and case management and surveillance activities were synchronized; there were a lot of agreements between the two countries. However, all normal cross-border activities have stopped since 2015, when the current war started.

This case study noted that it is difficult to estimate the contribution of imported cases from Yemen to local transmission in border provinces of Saudi Arabia. The malaria recession in the border provinces of Saudi Arabia is a likely consequence of multiple coincidental factors, including scaled elimination activities, cross-border vector control, periods of excessive and minimal rainfall, and economic development. The temporal alignment of many of these factors suggests that economic development may have changed the receptivity in the Jazan and Aseer regions to the extent that it mitigates surges in vulnerability posed by imported malaria from its persistently malaria-endemic neighbour Yemen.

5.3.4 Haiti and Dominican Republic

The Ouanaminthe (Haiti)-Dajabón (Dominican Republic) border shares a common ecology (two towns, one on each side of the Massacre River), has a related population that mainly meets in Dajabón, and has related malaria parasites and vectors – *P. falciparum* and *An. albimanus*. The transmission differential across the border is mainly from Haiti to Dominican Republic due to a gradient in intervention coverage. Haitians living in Ouanaminthe can cross the border freely without documentation on market days (07:00 to 17:00), but many arrive one day early and sleep in Dajabón. In addition, thousands of people cross the Massacre River daily to work or trade in the border towns. Haiti and Dominican Republic won the 2017 Malaria Champions of the Americas Award for successful cross-border collaboration. The activities of this collaboration include improved surveillance; the introduction of a rapid diagnostic test (RDT) for prompt diagnosis and harmonization of treatment; community engagement and sensitization using different languages; joint mapping of breeding sites and target vector-

control measures; and sharing of information through weekly meetings. From 2008 to 2017, there was an impressive reduction in cases on both sides (five cases in Dajabón, three of which were imported in 2017; and 77 cases in Ouanaminthe). The API has dropped from 1.35 to 0.67 per 1000 people in Ouanaminthe from 2011 to 2017, and from 19.08 to 0.07 per 1000 people in Dajabón from 2008 to 2017.

The successful reduction of malaria transmission due to this binational cooperation could be attributed to two factors: (1) the increase in coverage of quality interventions at both sites; and (2) the sharing of information to coordinate vector-control activities, increase vigilance when a case is detected on the other side of the border, and follow up on cases when they are detected on one side but returning to their place of origin. The commitment of health partners and maintaining funding to support the binational collaboration have been key to reducing transmission on the Ouanaminthe-Dajabón border.

5.3.5 Bhutan and India

Bhutan and India share an international border with unrestricted population movement. Bhutan borders with nine districts of India and plans to eliminate malaria by 2018, while India plans to eliminate malaria by 2030. Malaria is a notifiable disease in Bhutan. There is real-time monitoring of all cases through web-based reporting (notification, investigation and classification). There is 100% case detection and treatment for parasite clearance and radical cures. There is also 100% surveillance on migrant populations at entry points, and eight functional clinics. Bhutan provides universal coverage of LLINs for at-risk populations. On the India side, most of the settlements are illegal and are in forest areas. They are unreached by developmental activities and experience frequent security issues, particularly in Assam. Because the settlements are illegal, people have no access to public health care systems. Except for some pharmacy retailers, health care is not present. Most live in abject poverty. Population movement is unrestricted. Settlement across the border is within the flight range of mosquitoes.

There is no harmonized or synchronized cross-border collaboration for malaria activities, no collaboration at the local level, no information-sharing on malaria cases and outbreaks within the border areas, and no unit specifically responsible for cross-border collaboration. Most cases in Bhutan occurred in one district (Sampse), where it borders with Assam and West Bengal in India. The case study pointed out that malaria along international borders is not only a public health issue, but is a matter of human rights. A regional unit is needed for coordination and collaboration of cross-border activities, which should be synchronized with mobilized resources. Frequent coordination meetings should happen at the local levels.

5.3.6 Conclusions from case studies

- Border malaria is not only a public health issue but also a political, social and economic-development issue. A border is a political boundary between countries, and political unrest, conflict or civil war, and social security issues are common in border areas. Such unstable political environments represent a hindrance to the health agenda, including malaria. Social and economic development in border areas is slower and often lags behind other areas.
- Populations residing in border areas can be difficult to reach for a variety of reasons. Border areas can be remote with difficult terrain. Minorities, tribes or indigenous populations residing in border areas have their own cultures and languages, which

create barriers for delivering interventions. Undocumented people engaged in illegal activities, such as mining, may have significant barriers to accessing malaria prevention or treatment.

- In border areas, populations residing on two sides of the border often share the same community. Their movement is normally frequent, short-term and cyclical, and can be for business or personal purposes. Border malaria can occur due to different access to health care or unequal quality or cost for treatment.
- Access to health services or coverage of interventions is suboptimal in most border areas. Both border posts and community-based volunteer networks have been established to increase access to malaria services, but whether such measures are sufficient and effective should be assessed.
- Health systems and surveillance in border areas are often suboptimal compared with other parts of the country. The quality performance of a surveillance system in border areas is the key to success. To achieve that, capacity building in local health facilities in border areas must be strengthened. Ensuring sufficient human resources and financial support, as well as technical support, monitoring and supervision, are important for maintaining a strong surveillance system in border areas.
- Interventions:
 - Joint vector control, health education and response to outbreaks lowers incidence rapidly and significantly, and such collaboration at the local level is most efficient.
 - Harmonized treatment policy on both sides of the border is likely to help reduce transmission.
 - Joint case investigation, foci investigation, response and follow-up helps interrupt transmission in border areas.
- Information-sharing and coordination:
 - Difficulties in international coordination/border collaboration, as border areas may not be a priority for the country with higher transmission.
 - Information-sharing should happen at the local (district) level.
 - When one country is more interested than the other, a joint project might aid cross-border collaboration.

5.4 Experiences and lessons learned from other diseases

5.4.1 Border polio

As seen in case studies for border malaria, people move across borders because they belong to the same community or tribe and have extended families on both sides. They travel for social, medical and economic reasons. The movement may be seasonal or event-based, or may be due to displacement as a result of conflict, political issues or natural disasters. Drawing from the experiences of cross-border coordination between Afghanistan and Pakistan, key risks in border areas include: inadequately reached or underserved populations because the people belong to different tribes; people are unregistered and have poor access to health care due to

difficult terrain or insecurity; missing poliovirus transmission (due to incomprehensive health infrastructure, low surveillance sensitivity and/or health care-seeking behaviour); international spread/cross-border transmission (population movement); and difficulties in maintaining coordination across international boundaries.

5.4.2 Onchocerciasis elimination

The definition of cross-border disease transmission is “transmission that takes place across a border shared by two or more sovereign countries or on one side of the international border in a country within favourable ecological or social conditions and at a distance within which the potential for transmission across international borders exists”. Bureaucracy contributes to the difficulties in interrupting cross-border transmission of disease. The power and capacity of local health facilities in making decisions for disease control and elimination across borders is ignored. There are language barriers, geographical challenges and a lack of WHO resolutions or binational agreements on control/elimination for targeted diseases with cross-border transmission.

5.4.3 Lessons learned from polio and onchocerciasis programmes

- To achieve disease elimination or eradication, a well-structured and well-governed programme, a high-quality surveillance system, a clear strategy to efficiently reach high-risk and hard-to-reach populations, a timely response to detected cases/events, and high-quality coordination and synchronization of activities – specially in border areas (international and national) – are essential.
- The translation of technically sound strategies and policies into the lowest levels of implementation (at the lowest administrative division) is a key to success, but this is always challenging.
- Health facilities at the community and district levels along borders are the primary stakeholders. They should be empowered to make decisions on the ground. Engagement with all stakeholders (such as immigration and customs officials from border districts) in advocacy and implementation of strategies is beneficial to the interruption of transmission across borders. Timely communication between health workers and other stakeholders is needed.
- Border areas should be considered a single epidemiological block, as such functional coordination is critical and joint implementation of programme activities is important. It should be recognized that success on one side is never a complete success, and that in the end, coordination will benefit both countries that share a border. Periodic joint meetings should be organized to review progress and to plan for the future.
- Some good practices suggest that in elimination settings, a buffer area of at least 20 km could be established to assure there is no reinfection.
- A border issue is more of an operational issue, e.g., official communication from a high level to the border area can be time-consuming; no funding to support the work on the other side of the border.
- Genetic data can provide evidence of cross-border transmission.
- The WHO plays a critical role in cross-border collaboration. In Africa, resolutions and protocols by the WHO are well-respected.

- Anthropological studies about mobility patterns of specific groups can be useful in reaching mobile populations.
- Sharing data and information can be challenging if it is politically sensitive. An agreement is needed on which variables are of highest importance.

5.5 Border health posts

5.5.1 China-Myanmar border

The border malaria posts on this border are attached to existing health facilities – a township hospital, a private clinic, a rural health centre or even a county Centre for Disease Control, depending on the location of the health facilities and the estimated migrant or mobile population passing by. The original purpose of setting up border malaria posts on the long, porous border was to provide diagnosis and treatment for malaria and LLINs, and to distribute behaviour change communication (BCC) for the 1.5 million short-term migrants. Current activities at the border posts include distributing malaria packages, conducting blood examinations and conducting active case detection in border villages or townships. One study assessed such border posts, and found that as the programme moves toward its elimination goal, the proportion of positive slides captured at border posts is declining. The proportion of migrant workers tested at border posts is also declining.

5.5.2 GMS (Cambodia, Thailand and Laos)

Studies were conducted to understand moving patterns of malaria infection across international borders in order to prioritize and locate the border posts. Results showed that some occupational groups (such as forest workers and construction workers) had higher infection rates. RDT missed a lot of asymptomatic infection at border sites. Ongoing projects in this region are scaling up cross-border activities: first, to conduct active surveillance and map existing health facilities; and second, to implement a package of interventions, including operating mobile malaria posts and using community volunteers or mobile/migrant workers to provide malaria services.

5.5.3 E8

Border posts in this region are located along borders with a strong gradient between first-line and second-line countries. The posts are funded by a three-year grant from GFATM. So far, 39 border health facilities on five key international borders between high and low transmission districts of E8 countries have been established. The goal of these border malaria health posts is to improve access to malaria testing and treatment services, targeting two populations at risk of malaria: (1) mobile and migrant populations (MMPs), given the risk of infection importation to and from countries with varying risks of transmission; and (2) underserved residents of border districts. Locations were selected based on the highest number of border crossers and the lowest access, in consultation with countries and districts. There are three types of posts: malaria basic posts (which provide only malaria services and serve as a testing point for communities in high-traffic areas where MMPs congregate); malaria plus posts (which provide core diagnosis and treatment of malaria, as well as a basic package of primary health care); and leverage posts (which provide only testing and treatment commodities for malaria to existing HIV clinics in the border regions). Impact evaluation is designed to determine whether border posts have modified health-seeking behaviour and access to health care, have targeted

the right populations, have impacted transmission and have affected incidence in the surrounding facilities.

5.5.4 Conclusions

- Health posts in border areas can help increase access to malaria and other health services for underserved populations. Border health posts alone, however, may be insufficient to provide services to the entire population of a border area. In addition, determining how to make border health posts sustainable and to link them with existing facilities and the general surveillance system will need further discussion.
- Because international borders are often long and porous, some migrants or local populations may bypass official crossing points to avoid being stopped. There is lack of data on the effectiveness and cost-effectiveness of screening at border posts that seeks to reduce importation.
- Some border posts are not frequently used by people crossing the border. Experiences from polio suggest that vaccination posts alone are not sufficient to solve the problem, because people move all the time, and many groups deliberately try to avoid being tracked or identified, and therefore cross borders through unofficial points.
- Tracing changes in movement is essential to better target individuals/populations, but this can be challenging. In this context, flexible or mobile border malaria posts can respond and better target specific populations.
- Strong engagement with communities, local authorities and security forces, working with volunteers from target groups, and harmonization of approaches and messages on both sides of international borders are believed to be critical.

Annex 1: list of participants

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Annex 2: Agenda

Chairperson: Rick Steketee

Day 1 – Thursday, 10 May 2018		
8:30 – 9:00	Registration	
9:00 – 9:10	Introduction and welcome	Pedro Alonso
9:10 – 9:30	Conflict of interest, background, objectives and expected outcomes	Li Xiao Hong
9:30 – 9:50	Definition of border malaria Discussion	Li Xiao Hong
Session 1: Literature review on border malaria		
9:50 – 10:40	Presentation: Factors associated with malaria transmission along international borders and strategies to intervene (30') Discussion (20')	Matiana González-Silva
Session 2: Case studies on border malaria (1)		
10:55 – 11:30	Case study 1: Namibia – Angola (30') Clarify issues (5')	Regina Rabinovich
11:45 – 12:20	Case study 2: China – Myanmar (30') Clarify issues (5')	Li Xiao Hong
12:20 – 12:40	Presentation: Border malaria post (20')	Arantxa Roca-Feltrer Adam Bennett Li Xiao Hong
12:40 – 13:30	Discussion	
Session 2: Case studies on border malaria (2)		
14:30 – 15:05	Case study 3: Saudi Arabia – Yemen (30') Clarify issues (5')	Mohammed H Alzahrani
15:05 – 15:40	Case study 4: Haiti – Dominican Republic (30') Clarify issues (5')	Blanca Escribano
16:00 – 16:35	Case study 5: Bhutan – India (30') Clarify issues (5')	Tashi Tobgay
16:35 – 17:30	Discussion	
17:30 – 17:50	Summary of Day 1	Kim Lindblade

Day 2 – Friday 11 May 2018**Session 3: Interrupting cross-border transmission: experiences from other diseases**

9:00 – 9:20	Experiences from polio	Mufti Zubair Wadood
9:20 – 9:40	Experiences from onchocerciasis and lymphatic filariasis	Moses Katarbarwa
9:40 – 10:10	Discussion	
10:30 – 12:30	Group Discussion Group 1: Improve definition of border malaria Group 2: Interventions for border malaria Group 3: Information sharing and coordination	
12:30 – 13:20	Report back	
Closed session		
14:20 – 5:30	Draft recommendations for reducing malaria along international borders	Chairperson
15:45 – 17:00	Continue work on draft recommendations	
17:00	Closure	Pedro Alonso