Documentation related to Session 8 of the meeting
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Malaria Policy Advisory Committee (MPAC) Meeting, 10–12 April 2019

Documentation related to Session 8

Thursday, 11 April 2019			
	Session 8	**Open**	
16:15 – 17:00	Update on the 1) Malaria Elimination Oversight Committee Background | Presentation and 2) STOP Malaria Background | Presentation	Dr Frank Richards Dr Kim Lindblade	**For guidance**
17:00 – 17:30	Outcome of the technical consultation on external competence assessment of malaria microscopy Background | Presentation	Dr Andrea Bosman	

World Health Organization

Global **Malaria** Programme

Malaria Elimination Oversight Committee (MEOC) focused review meeting

FEBRUARY 2019

MEETING REPORT

SUMMARY

The third meeting of the Malaria Elimination Oversight Committee (MEOC) was held in Geneva on 12–14 February 2019. Seven countries (Belize, Bhutan, Cabo Verde, Costa Rica, Malaysia, Suriname and Timor-Leste) considered on track for elimination by 2020 were invited for focused review sessions to examine their programme's performance and achievements and to identify additional issues that could be addressed to improve effectiveness. All 10 full members of the MEOC attended the meeting, along with the national programme manager of Armenia as an adjunct member representing the certified countries. National malaria programme representatives from six of the seven invited countries attended, along with WHO country, regional and headquarters staff, and fund portfolio managers and monitoring and evaluation officers from the Global Fund to Fight AIDS, Tuberculosis and Malaria (GFATM).

Each eliminating country presented on their progress towards elimination and their programme's activities, successes and challenges. All countries except for Costa Rica reported a reduction in case numbers in 2018 compared to 2017, and two countries (Malaysia and Timor-Leste) reported zero indigenous malaria cases in 2018. The MEOC developed individual country recommendations in collaboration with the national programme managers, WHO and GFATM staff, as well as overarching recommendations to WHO and partners. The MEOC will meet next at the 2019 Global Forum of malaria-eliminating countries in Wuxi, China in June.

Overarching recommendations

1. The MEOC recognized the critical importance of GFATM resources in helping many countries to achieve elimination, and made the following observations:

    - It is vitally important to continue to support surveillance and response plans in countries on the verge of elimination, until certification (and beyond) while countries remain receptive and at risk of malaria importation.

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- Funds could be earmarked to higher burden countries that border eliminating countries in order to reduce transmission in cross-border foci. This would be very helpful to the eliminating country. Alternatively, these areas might be considered and funded as "special intervention zones".
- It would be helpful to encourage country coordinating mechanisms (CCMs) with shared borders to enter into formal dialogue.
- Creating opportunities for WHO to brief members of the Global Fund Technical Review Panel (TRP) and Technical Evaluation Reference Group (TERG) and fund portfolio managers (FPMs) on elimination strategies and the challenges of eliminating countries that could be better addressed in Global Fund grants would be helpful.
- Encouraging catalytic and contingency fund mechanisms available on an emergency basis to address outbreaks could support countries close to elimination that are prone to outbreaks.

2. WHO should advise countries when they are implementing strategies that are not recommended by WHO (e.g., using long-lasting insecticidal nets [LLINs] and indoor residual spraying [IRS] concurrently).

3. The MEOC should study regional initiatives such as the Regional Malaria Elimination Initiative in Mesoamerica to understand how they support elimination.

4. WHO should develop a structured approach to programme auditing.

5. WHO should develop clear and rational criteria for the classification of malaria cases (indigenous, imported, introduced, etc.) by personnel.

6. Through the Chair's annual presentation to the Malaria Policy Advisory Committee (MPAC), the MEOC will raise the issues around simian malaria cases and elimination.

BACKGROUND

The World Health Organization's (WHO) *Global Technical Strategy for Malaria 2016–2030* (GTS) was adopted by the World Health Assembly in May 2015. One of the three pillars of the GTS calls for all malaria-endemic countries to accelerate efforts towards elimination and attainment of malaria-free status. A number of countries have had remarkable success in controlling malaria. Although these achievements have been hard-won, elimination is not assured. Countries face considerable challenges in their efforts to control malaria, achieve zero indigenous cases and subsequently prevent resurgences of malaria.

The GTS sets the milestone of 10 countries to eliminate by 2020. According to an analysis presented in the *Eliminating malaria* report released by the Global Malaria Programme (GMP) on World Malaria Day 2016, 21 countries have been identified as having the potential to eliminate malaria by 2020, based on 1) the total number of indigenous malaria cases reported from 2000 to 2014; 2) the declared malaria objectives of the country; and 3) the informed opinions of WHO experts in the field. The countries identified were: Belize, Costa Rica, Ecuador, El Salvador, Mexico, Paraguay, Suriname, (PAHO); China, Malaysia, Republic of Korea (WPRO); Iran (Islamic Republic of), Saudi Arabia (EMRO); Algeria, Botswana, Cabo Verde, Comoros, Kingdom of Eswatini, South Africa (AFRO); and Bhutan, Nepal, Timor-Leste (SEARO). These 21 countries are the special focus of WHO endeavours to accelerate national elimination efforts and monitor progress towards malaria-free status. They are referred to as the Elimination-2020 (E-2020) countries.

The E-2020 countries are spread across five WHO regions. While the countries share some common challenges in eliminating malaria, they face different and unique challenges inherent to each region and country. As the E-2020 countries are at different points along the continuum of transmission, the approach to malaria elimination will differ from country to country, depending on the epidemiology of malaria in the country, strength of the surveillance systems, level of domestic and external funding, and political commitment. However, these countries also share some similarities, including vulnerability to the importation of malaria from migrants, visitors and mobile populations. One issue that is increasingly evident is the important effect that adjacent malarious countries have on their E-2020 neighbours.

In March 2017, the WHO Malaria Policy Advisory Committee (MPAC) endorsed the creation of a new committee to support malaria elimination: the Malaria Elimination Oversight Committee (MEOC).[1] The terms of reference for the MEOC include:

- evaluating national and regional progress towards malaria elimination according to established milestones and timelines;
- determining the need for corrective actions to address programmatic or operational bottlenecks, and evaluating plans developed to address such issues;
- identifying any risks to malaria elimination that need to be addressed by WHO, regional initiatives or national programmes;
- providing observations and/or draft recommendations to WHO/GMP with respect to policies or guidance related to malaria elimination, for MPAC consideration;
- questioning the status quo and confronting difficult issues.

The MEOC had met twice prior to this meeting: first to inaugurate the Committee in April 2018 in Geneva, Switzerland, and second in conjunction with the Global Forum of malaria-eliminating countries in June 2018 in Costa Rica to review the progress and challenges of the E-2020 countries.

General objective

The purpose of the meeting was to convene the MEOC and Ministry of Health (MoH) staff from countries that are on track for malaria elimination and where expert opinion suggests that the 2020 elimination target can be met. The objective of the meeting was to conduct a focused programme review with countries to identify programme components that need to be addressed in order to improve operational performance, and for the MEOC to identify overarching issues or lessons learned. The countries identified to participate in the focused review meeting were Belize, Bhutan, Cabo Verde, Costa Rica, Malaysia, Suriname and Timor-Leste. These seven countries experienced an 80% decrease in cases between 2017 and 2018, and two of them (Malaysia and Timor-Leste) reached zero indigenous human malaria cases in 2018.

The specific objectives of the meeting were to:

- review progress to determine whether the country is on track to achieve elimination by 2020;
- analyse audit reports from national elimination programmes to identify programme structures, organization, management and activities that are missing, inadequate or not in alignment with WHO guidance;
- jointly develop solutions to major challenges or barriers to elimination;

- identify needs for high-level advocacy to address problems requiring solution at high levels of government;
- share lessons learned and experiences among eliminating countries at similar stages.

Method of work

Before the meeting, national malaria programmes were asked to complete an annual progress report, which will also form the basis for their future national malaria certification report. On the first day of the meeting, each country gave a 30-minute presentation on the status of their programme, using a template based on the annual progress report, which was provided by the WHO Secretariat. Participants asked clarifying questions that could be answered briefly and immediately, and in-depth questions were noted down to be answered the next day.

On the second day, the MEOC members conducted focused review sessions with each country team. Two MEOC members were chosen as the focal points for each country, responsible for leading the discussion, taking notes and proposing recommendations. The meetings were also attended by WHO Secretariat staff and regional malaria elimination focal points, as well as by portfolio managers and monitoring and evaluation specialists from the Global Fund to Fight HIV/AIDS, Tuberculosis and Malaria (GFATM) if the country was a GFATM recipient. Programme weaknesses and areas for improvement were identified jointly by the programmes, WHO staff and MEOC members; GFATM staff also engaged in the discussions to identify possible opportunities to reprogramme grants based on identified needs. Key recommendations were shared with the national programmes during a plenary session at the end of the second day.

On the third day, the MEOC members, WHO Secretariat and regional malaria elimination focal points met for a half-day session to finalize country and overarching recommendations. Additionally, WHO briefed the MEOC members on upcoming certification requests and other elimination-related activities.

MEETING OPENING

The Director of GMP, Dr Pedro Alonso, opened the MEOC meeting by welcoming the MEOC members and representatives from the national malaria programmes. Dr Alonso provided a brief update on the global malaria situation and urged the seven countries present to help achieve the elimination milestones set out in the *Global Technical Strategy for Malaria 2016–2030* (GTS). The Chair of the MEOC, Dr Frank Richards, said a few words of welcome and declared the MEOC to be the "committee of good news", as the countries reaching zero malaria cases and certification were helping to keep positive reports on malaria in the news.

SUMMARY OF THE PRESENTATIONS AND MEOC RECOMMENDATIONS TO COUNTRIES

Presentations from each country will be briefly summarized below in the order they were given to the committee.

Timor-Leste

Timor-Leste reported zero indigenous malaria cases in 2018, 17 in 2017 and 91 in 2016. Timor-Leste is a new country, having declared independence in 2000. It shares the island of Timor with West Timor, Indonesia. In the past, malaria was a leading cause of morbidity, but the malaria burden has since declined substantially. The country reported seven imported cases in 2018: one female aged 0–4 years old, and five males and one female 15–59 years old. Most imported cases have been among Timorese returning from travel to Indonesia. The municipality and special administrative region of Oecusse is physically separated from the rest of Timor-Leste and surrounded by Indonesia. Three of the imported cases in 2018 came from this municipality. The primary and secondary malaria vectors in Timor-Leste are *Anopheles barbirostris* and *An. subpictus*. Both species can be found throughout the country, except at altitudes above 1500 m above sea level (asl). The country has prioritized providing universal, free access to malaria diagnosis and treatment throughout the country in order to ensure that all infections are detected and treated early. Active case detection is undertaken in border areas and among migrants and fishermen. Vector control includes distribution of long-lasting insecticidal nets (LLINs) to all households within 2 km of the border with West Timor, as well as on Atauro Island. These mass distributions are held every three years and supplemented through continuous distributions to pregnant women, migrants, fisherman and other high-risk groups in the border areas, Oecusse and Atauro Island. In addition to LLINs, the country conducts indoor residual spraying (IRS) campaigns annually before the malaria transmission season in all households within 2 km of the border and throughout Oecusse and Atauro Island. The class of insecticide used for IRS is rotated annually to prevent development of insecticide resistance.

Malaria cases are notified to authorities within 24 hours to allow for a rapid response. Within five days, case investigations are conducted to determine the case classification and likely location of infection, and response activities are initiated within 10 days. Reactive case detection is conducted as part of focus investigations within a 1.5 km radius of the index case. This process is repeated twice at 14-day intervals and once per year for three years to ensure there is no ongoing transmission. Entomological surveys are also conducted within a 1.5 km radius to determine availability of vector, vector bionomics, potential breeding sites and insecticide susceptibility. As part of the response activities, IRS is conducted in all residences within 1.5 km of the index case, and LLINs are either provided, if the area was not covered under a mass campaign, or topped up.

The country's challenges to achieving and maintaining elimination are related to the potential for cases imported from West Timor. The country first held a cross-border meeting with Indonesia in February 2017. A high-level meeting will be held with policy-makers and technical officers from both countries in February 2019 to develop a cross-border action plan. This will be followed by another technical meeting in March 2019 to agree on how the action plan will be implemented. In future, technical meetings will be held quarterly.

Timor-Leste has challenges related to G6PD testing of the population to provide primaquine treatment in the case of *Plasmodium vivax* or mixed infections. They are working towards including prophylaxis for Timorese travelling to Indonesia or other risk areas in their national treatment protocol. While the country has made significant strides in facilitating the reporting of malaria cases from the private sector, including ensuring that only the public sector is able to import antimalarial medications, currently 23 (66%) of 35 private facilities report to the MoH. The MoH is working to strengthen the legislation around private sector reporting. A significant challenge for malaria elimination and prevention of re-establishment in Timor-Leste is the degree to which the National Malaria Control Programme (NMCP) is financed through their grant from the GFATM. Currently 80% of the officers serving in the NMCP are funded by GFATM.

Timor-Leste has a national malaria elimination committee (a technical working group) as well as an independent malaria advisory committee. Both committees assist with confirmation of case classification. The technical working group meets routinely to discuss progress and update activities. While a special elimination committee was planned for Oecusse, the change in government has delayed implementation, which is now expected for 2019.

Recommendations from MEOC

1. Given the achievement of zero indigenous malaria cases in 2018 and the fact that the country has now exceeded 17 months without an indigenous malaria case, Timor-Leste should start preparing the documentation and planning required for WHO certification.

2. Timor-Leste needs to achieve and maintain a balance between current elimination efforts (including vector control, active surveillance along the border, etc.) and enhancing the overall surveillance and response system, with a view to eventually sustaining elimination status.

3. Timor-Leste should develop a financial and human resources plan for sustaining interruption of transmission after cessation of the GFATM grant by improving efficiencies and planning for increased domestic financing.

4. Promising measures are underway for greater cooperation with West Timor to control malaria across the border. Continued improvements in collaboration and cooperation in border areas with West Timor should be actively pursued in order to sustain malaria elimination in Timor-Leste.

5. There is a need to clearly determine the origin of cases along the porous border with West Timor in order to differentiate introduced cases from indigenous cases.

6. The NMCP should continue to support the private sector both in the diagnosis of malaria and in increasing the proportion of private clinics reporting malaria cases.

Malaysia

Malaysia reported zero indigenous human malaria cases in 2018, 85 in 2017 and 282 in 2016. Malaysia borders Thailand to the north on the Malay Peninsula, and Brunei Darussalam and Indonesia on the island of Borneo. In addition, frequent travel between Palawan in Philippines opens an 'ocean border' with the Philippines in the Sabah province.

Malaysia's specific elimination strategies have been developed in accordance with WHO guidelines. Emphasis is placed on surveillance through development of a web-based focus registration system that classifies focus status as active, residual non-active, or cleared. The country has also made a concerted effort to prevent re-establishment in its malaria-free territory through innovative approaches to indices for receptivity and vulnerability. Foci with high indices for these factors have a set of interventions implemented to prevent reintroduction of malaria transmission. Equity issues are addressed by the national programme, ensuring that the segments of the population that are impoverished, marginalized or vulnerable are equally protected.

The country registered 478 imported and 21 introduced human malaria cases in 2018. The country had only one active and one residual non-active focus remaining in 2018. The majority of imported and introduced human malaria cases were *P. vivax* (between

51% and 58% since 2015). Most imported cases (475/478, or 99%) were over the age of 15, and most (98%) were male. The age and sex distribution of introduced cases was similar to that of imported cases. Most (72%) of the imported cases were Malaysian nationals who acquired the infection largely from Papua New Guinea (40% of imported cases whose origin could be determined). Despite sharing borders with Thailand, Indonesia and Philippines, those countries were responsible for only three (0.7%), 23 (5%) and zero (0%) imported cases, respectively, in 2018.

The vector profile is complex, with unique sets of vectors on peninsular Malaysia, Sabah and Sarawak. All vectors tested remain susceptible to pyrethroids. Sentinel sites for entomological surveillance have been established at representative sites across both the Malaysian Peninsula and Sarawak and Sabah.

Malaysia's elimination strategy includes vector control, case management and surveillance and response. The majority of cases are identified through passive surveillance. In areas with risk groups, a proactive approach is taken to screen high-risk groups for malaria symptoms and then test those who are positive. Active case detection targets military, indigenous people in West Malaysia, mobile ethnic groups in Sarawak, and isolated, forest communities in Sabah. Mass testing and treatment are conducted proactively every six months in high-risk areas, in conjunction with IRS and re-treatment of insecticide-treated nets (ITNs). Mass testing and treatment may also be conducted during outbreaks. Reactive case detection is conducted around local cases. Potential 'contacts' of cases are grouped into four categories, tested and treated:

- Category 1: household residents
- Category 2: contacts with exposure at the same place of infection (i.e., friends and coworkers)
- Category 3: contacts with exposure at the same place of infection but who live elsewhere
- Category 4: household contacts of those in Category 3.

Malaysia has adapted the China 1-3-7 model into a 1-3-7-42 approach wherein every case is considered an outbreak. Case notification is mandatory within 24 hours; case investigations take place within 1–3 days after case notification; focus investigation, classification and registration, and the first cycle of vector control occur within 7 days; and the community is followed up for 42 days, after which the outbreak is considered to have ended. All case classifications are reviewed internally by a MoH national review committee, as well as by independent reviewers from universities and public health research institutions within Malaysia.

Vector control is directed at the population at risk, defined as: those living within active or residual non-active foci; people living in cleared foci with a medium to high receptivity/vulnerability index; and special populations including aboriginal people and foreign workers. In 2016, Malaysia began a switch from re-treating ITNs to purchasing LLINs. In 2018, the country distributed more than 100 000 LLINs across the country. IRS was used in more than 82 000 households in 2018. Insecticide resistance surveillance is conducted at five sentinel sites, representing the three main regions in Malaysia.

Although Malaysia reported zero indigenous human malaria cases in 2018 within its territory, the number of zoonotic malaria cases due to *P. knowlesi* continues to increase, as do the number of deaths due to *P. knowlesi*. In 2018, there were 4131 cases of zoonotic malaria. As it currently stands, there is no evidence-based strategy to control *P. knowlesi*. The eventual certification of the country as free of human malaria will present a communications challenge given the large number of zoonotic malaria cases.

Malaysia uses several platforms to collaborate with its neighbours. These include exchange of information, notification about outbreaks and harmonization of activities. Malaysia's National Malaria Programme is fully funded by the government.

Recommendations from MEOC

1. WHO should liaise with senior officials in Malaysia to support the programme, emphasizing three key areas:
    - the need to reduce staff turnover for key technical support staff: currently many move after one year, but staff retention for at least three years would be more sustainable;
    - the need to maintain financial support for the programme;
    - the need to upgrade the surveillance system software to make it fit for the elimination phase rather than the control phase for which it was developed.
2. It is important to increase the awareness of the need for prophylaxis for Malaysians travelling to malaria-endemic areas outside of the country.
3. Cross-border collaboration at the local and technical level is adequate though somewhat informal. There would be a benefit from increased strategic and coordinated collaboration. This might include areas such as cross-audits of programmes by neighbouring country programmes and development of a more formal mechanism for border surveillance and information exchange.
4. There needs to be a major focus on the *P. knowlesi* challenge. Two areas for attention are:
    - development of a communications strategy for (a) target groups, (b) the general public and (c) an international audience in order to explain how it is both possible and beneficial to undertake the elimination of human malaria while still having zoonotic malaria;
    - development of a specific evidence-based strategy for *P. knowlesi* control. It may be helpful to convene a series of meetings to bring the programme, Malaysian universities and international researchers together to review the evidence base and develop a research programme around control of *P. knowlesi*.
5. A structured audit of the malaria programme and its components could be helpful to ensure all aspects are functioning as expected.

Cabo Verde

Cabo Verde reported two indigenous cases of malaria in 2018, after halting a large malaria outbreak in 2017 with 423 indigenous cases and reporting 47 indigenous cases in 2016. For the 12 months following the two cases that occurred in January 2018, Cabo Verde reported no new indigenous cases. During the outbreak, all indigenous cases were reported from the municipality of Praia, the capital city located on the island of Santiago. The majority of cases were males aged ≥20 years, with a few malaria cases in children and two reported in pregnant women. The cause of the epidemic was *P. falciparum*, confirmed through use of both rapid diagnostic tests (RDTs) and microscopy. The vector in Cabo Verde is *An. gambiae s.l.*

Cabo Verde is an archipelago of 10 islands located in the Atlantic Ocean, 570 km from the West African coast. The island nation has a population of approximately 500 000 persons. With a GDP per capita of US$ 2998, it is categorized as a lower middle-income

country. Until the late 1950s, Cabo Verde reported between 5000 and 15 000 malaria cases per year. Since that time, Cabo Verde has twice achieved malaria elimination using IRS, but both times, transmission of malaria was re-established after IRS was withdrawn. As an island nation, the country does not have to contend with mass importations from bordering countries, but there is considerable movement of Cabo Verdeans to and from the continent and of persons from other malaria-endemic African countries to Cabo Verde. As a result, the country identifies multiple imported malaria cases every year. There has been a steady decline in the annual number of indigenous malaria cases since 2009, with only one indigenous case reported in 2012.

Cabo Verde launched a vigorous response to the 2017 epidemic, including re-training all IRS spray operators to improve the quality of the operations, re-spraying all households in the affected areas of Praia, creating a special malaria treatment unit at the central reference hospital, strengthening passive surveillance, initiating reactive case detection and conducting vector insecticide susceptibility testing. The epidemic occurred between July 2017 and January 2018, and there have been no indigenous cases registered since that time.

Vector control is achieved through IRS and larval source management. The latter takes several forms: environmental modification with the drainage and restoration of several canals that drain water into the ocean, and use of *Gambusia* spp. fish in cisterns, temephos in drinking water, and diesel oil in stagnant water.

Cabo Verde detects most cases through passive surveillance at health clinics and the central reference hospital. Antimalarial medications are only available in the public sector from the central hospital. Peripheral clinics have access to RDTs for diagnosis, but all positive cases are referred to the central hospital for microscopy and treatment. Cases are hospitalized for three days until their parasitaemia is cleared. Patients are followed after discharge through day 28 to ensure complete cure. When cases are found, reactive case detection is conducted among symptomatic individuals up to 100 m from the index house, along with focal IRS and focal larviciding.

Cabo Verde is in the process of a malaria programme review to inform a new strategic elimination plan. The country is also working to establish an independent National Advisory Committee for malaria elimination.

Cabo Verde is part of the Sahel Malaria Elimination Initiative that has brought together eight countries of the region to collaborate on reducing malaria transmission.

Recommendations from MEOC

1. Recognizing Cabo Verde's achievement of 12 months with no indigenous cases, the country is urged to consolidate this achievement and take all necessary steps to keep it free of indigenous malaria.

2. Cabo Verde should put the necessary elements together to complete their plan for elimination and put it into action, with attention to the following:

    - ensuring reorientation of the programme mindset and national strategy from control to elimination;
    - establishing an active surveillance system among migrant populations and an entomological surveillance system, supported by a functional database;
    - improving the human resources available at all levels of the national programme;
    - ensuring sustainable financing of the programme.

While acknowledging the significant political will that exists, there is need to ensure that this continues now that zero cases have been achieved. Additionally, there is a need to translate the prevailing political climate into increased financing, technical improvements and all other components of the programme to ensure the sustainability of the achieved results.

Suriname

Suriname reported 33 indigenous malaria cases in 2018, 40 in 2017 and 77 in 2016. Suriname is part of the Guiana Shield, an eco-region that covers an area of 270 million ha and is made up of various critical ecosystems. Suriname is the smallest independent country in South America, situated between French Guiana to the east and Guyana to the west. The southern border is shared with Brazil and the northern border is the Atlantic coast.

P. falciparum was the predominant malaria species in Suriname until 2006, after which it declined to 7.1% (six cases) of indigenous cases in 2016. *P. falciparum* was still found in 39.9% (106 cases) of the imported cases in 2016. Since 2007, *P. vivax* has been the predominant species for indigenous Surinamese cases. The priority vector is *An. darlingi*. Historical studies during high-incidence times (1980s) showed that *An. darlingi* biting densities increased during the rainy seasons, following increased water levels in the rivers.

The population at risk for malaria in Suriname is composed of stable and mobile populations in the interior of the country. The stable populations are Maroon and Amerindian populations living in tribal villages along rivers in the forests of the interior. Since 2007, the population at risk was extended to include the mobile gold-mining communities in remote areas in the forest. These are mostly migrant miners of Brazilian origin. The total number of population at risk varied from 47 372 in 2000 to 80 000 in 2018. This increase was due to both stable population growth and the inclusion of mobile migrants as a risk population. The number of mobile migrants is unknown and varies depending, among other things, on gold availability, gold prices and military counterintervention in neighbouring countries (especially in French Guiana). It is estimated at around 20 000 people.

Suriname is confronted with significant challenges with respect to policies in neighbouring French Guiana, an overseas territory of France. As a result of efforts to limit illegal gold mining, Brazilian miners in French Guiana, who have little to no access to care in French Guiana, enter Suriname to seek health care and evade French military forces.

Both indigenous and imported cases in Suriname have decreased significantly since 2000, after an initial peak in 2001 of 12 197 cases to a low of 235 cases in 2018, of which 34 were indigenous. Imported malaria cases have been recorded separately since 2004 and have steadily increased in proportion over time, from 5.4% of the total number of confirmed cases in 2004 to 75.6% in 2016. Most imported cases registered in Suriname have originated from French Guiana (94.2% between 2004 and 2016) among individuals of Brazilian nationality (89.4% between 2007 and 2016).

Vector control for malaria is currently achieved through use of LLINs, first introduced in 2006. Almost 13 000 LLINs were distributed in 2018 to mining areas and stable communities at risk. Entomological surveillance is irregular, and insecticide resistance testing of *Anopheles* mosquitoes was last conducted in 2014.

Passive and active case detection methods are deployed with the use of both microscopy and/or RDTs. Case reporting is done via the standardized surveillance form, accompanied with the case investigation form if positive. Cases are often notified prior to

sending the forms to the central level by radio communication system (Medical Mission) or by phone (calls and text message). The national database does not include how (passive, proactive or reactive) cases were detected.

Suriname has joined with partners to conduct an evaluation of a novel approach to reaching highly mobile populations. The Malakit is a self-contained malaria diagnostic and treatment kit provided to persons who are involved in or working at illegal gold mining in French Guiana. They are trained on how to use RDTs and how to complete a full treatment course. The pilot began in 2018 and has yet to be fully evaluated.

Recommendations from MEOC

1. A major weakness identified by the country was the dependency on external funding to meet the expense of operations in the interior of the country where malaria cases occur. This situation needs to be addressed urgently to ensure the sustainability of activities.

2. The highly mobile, migrant mining population in French Guiana is the major source of imported malaria into Suriname. This population lacks malaria services in French Guiana and is a source of a continuous importation of malaria cases into Suriname. The policies of the French Government in French Guiana that affect the malaria situation need to be addressed at the highest political levels. WHO should take the lead on initiating dialogue with France regarding the situation.

3. A review of cases reported in 2018 indicates the possibility that, while there was limited ongoing transmission of malaria in Suriname, some of the 33 cases classified as indigenous in 2018 were likely acquired in French Guiana or at the border. It is a challenge for the programme to classify cases accurately due to the inability to get honest travel histories from cases, as they may fear repercussions from providing complete information about their travel to the border or into French Guiana. The programme is urged to identify the minimal essential data on the diagnostic intake form that would allow the correct classification of cases.

4. The MEOC commended Suriname for its innovative work in delivering malaria services through border posts and for the pilot project in migrant self-diagnosis and treatment (Malakit).

5. Cross-border collaboration with other neighbouring countries (Brazil and Guyana) is needed to tackle the issue of malaria among migrants. Improved information exchange is especially needed between the Guyanese and Surinamese programmes.

Costa Rica

In 2018, Costa Rica registered 70 indigenous malaria cases, compared with 12 in 2017, four in 2016 and zero in 2014–2015. Costa Rica is bordered to the north by Nicaragua and to the south by Panama, a situation that has led to re-establishment of transmission in this Central American country after it appeared to have interrupted malaria transmission in 2014 and 2015. Most (76%) of the 38 imported cases in 2018 were of Nicaraguan origin.

In 2018, an illegal gold-mining operation started in northern Costa Rica, which has attracted many migrants from Nicaragua. After identifying an initial cluster of malaria cases associated with the gold mine, the MoH began active case detection among the mining communities to identify cases that were not seeking treatment. The majority of indigenous cases registered in 2018 were identified through active surveillance in San Carlos Canton, the area where the illegal mining is occurring.

Costa Rica has an excellent health care system, with the public sector overseen by the Costa Rican Social Security Fund. The approach to malaria elimination relies heavily on surveillance and response. There is no proactive vector control, but significant actions are taken when cases are identified by the passive surveillance system, including reactive case detection within a radius of 500 m of the index case, after case investigations have determined the likely location of infection and case classification. Costa Rica is working to implement the PAHO operational strategy of Detection-Treatment-Investigation-Response (DTIR) and to develop micro response plans for each of the six active foci.

Recommendations from MEOC

1. Costa Rica should continue the intense work in the illegal gold mining communities in order to detect and treat all cases and prevent any further introduction. The country should strengthen intersectoral collaboration with migration, security and local officers.

2. The 2018 outbreak should be documented, including cost analysis, so that lessons can be learned and similar situations prevented both in Costa Rica and other eliminating countries.

3. Costa Rica's entomological capacity should be strengthened and entomological surveillance should be planned in risk areas.

4. RDTs should be deployed to public health services, particularly in the most vulnerable areas.

5. PAHO and COMISCA should support Costa Rica jointly and quickly to establish a mechanism for dialogue (binational border committees) with Panama and Nicaragua in order to try to reduce potential importation from those countries.

6. Vector control should be implemented in the areas with the greatest malariogenic potential.

Belize

Although representatives of the Belize malaria programme were not able to attend the meeting in person, they presented their programme via teleconference.

Belize registered three indigenous cases in 2018, down from seven cases in 2017 and four in 2016. The history of malaria control in Belize prior to the eradication era is not well documented. In 1930, records of deaths in health facilities in what was then called British Honduras indicate that more than 10% were due to malaria. In 1939, an estimated 50% of the population outside of city centres had malaria, and severe malaria was particularly common in the southern districts.

Belize launched an IRS programme in 1950 that was so effective that malaria had essentially disappeared by 1963, and the National Malaria Eradication Service (NMES) ceased regular spraying activities under the consolidation phase of its elimination strategy. Unfortunately, cases reappeared after spraying was stopped, and throughout the 1960s and 1970s, the malaria burden fluctuated in response to the inconsistent implementation of IRS. By 1982, over half of all localities in Belize's six districts had reported malaria cases. Incidence continued to rise in the early 1980s, a trend attributed to the shrinking NMES budget, as well as an influx of refugees from neighbouring endemic countries during the political upheaval. From 1985–1989, USAID provided assistance to the Vector Control Unit (VCU) of the National Malaria Service, as it had been renamed, through provision of vehicles and spray equipment and overall strengthening of

the programme. Cases declined during this period. The conclusion of USAID support and the inconsistent application of IRS as a result of inadequate funding of the VCU resulted in a reduction of spraying activities throughout the early 1990s. In 1994, in response to environmental concerns regarding the safety of DDT, the VCU limited spraying to only those localities along the border with Mexico. The consequences were seen immediately: approximately 10 000 cases were reported annually throughout Belize in 1994 and 1995, nearly doubling the caseload of 5341 reported in 1992. After DDT was banned, deltamethrin was introduced.

Health system decentralization in 2001 divided the country into four health regions with services managed by regional administrations. Decentralization resulted in competition for finances by various health programmes. The gradual improvement in the network of voluntary collaborators and community nurse aides (now community health workers) to increase surveillance, and renewed mass IRS led to the gradual decrease in malaria seen today.

The main malaria vectors in Belize are *An. albimanus*, *An. vestitipennis*, *An. darlingi* and *An. pseudopunctepennis*. Insecticide resistance data are outdated, but the national strategic plan will prioritize conducting tests.

Passive case detection in health facilities is supported by a network of approximately 300 community health workers and voluntary collaborators. Active case detection may be conducted in prioritized localities at least monthly and then periodically throughout the year in high-risk populations such as sugarcane and banana workers. Reactive case detection is conducted up to 500 m to 1 km from an index case within 72 hours of case detection. Focus investigations are conducted to identify factors contributing to transmission.

Financing for the Belize programme is primarily domestic, provided by the Government of Belize. Belize is part of the InterAmerican Development Bank's Regional Malaria Elimination Initiative.

Recommendations from MEOC

1. Belize should take steps to strengthen the surveillance system (particularly passive) in a sustainable manner, including capacity strengthening of frontline health staff.

2. Human resource planning and development should be carried out and long-term personnel succession plans put in place to ensure availability of the needed trained human resources, e.g., entomologists.

3. The country should continue to invest in efforts to establish cross-border collaboration with Guatemala and Mexico, as this is critical for the last mile of malaria elimination.

4. It should be ensured that microscopy skills are maintained and a quality assurance system for microscopy results is in place.

5. The country should implement clear and relevant strategies to reach the mobile and migrant population with screening and services.

6. Belize should seek support from PAHO to help with advocacy for the malaria programme at the highest political levels.

7. PAHO should assist Belize to establish a National Malaria Elimination Advisory Committee.

Bhutan

Bhutan reported six indigenous cases in 2018, compared to 11 in 2017 and 15 in 2016. Bhutan borders India to the south and east and China to the north. Most malaria cases are due to *P. vivax*, and most local cases between 2013 and 2018 were in individuals over 15 years of age. Most (68%) imported cases have been among those of Indian nationality. Remaining areas of transmission in Bhutan are all located along the international border with India.

The major vector in Bhutan is *An. minimus*. Vector control is achieved through use of LLINs, IRS and larval source reduction. Surveillance is through passive case detection in health facilities, while active case detection is conducted in high-risk areas. Reactive case detection is undertaken within 1 km of an index case. Focus investigations are to be completed within 48 hours.

Bhutan's greatest challenge to elimination is the proximity of the Indian border and the lack of malaria control on the Indian side. Despite several cross-border initiatives facilitated by WHO over the years, there has been no effective engagement between Indian and Bhutanese officials to share information or develop joint action plans.

Recommendations from MEOC

1. Although the country has been very close to elimination for the past 2–3 years, there are obvious weaknesses in the system that need to be addressed in order to make further progress to interrupt local transmission and maintain malaria-free status. Although national guidelines are available, field and central level staff are insufficient for effective implementation.
    - Increase the number of field staff in border districts.
    - Ensure training at the central level for improved epidemiological analysis and effective use of data.
2. Financial resources:
    - Ensure the availability of adequate financing for staff resources and implementation of case and entomological surveillance and response in the border districts.
3. WHO should provide immediate assistance to Bhutan on case classification. Given the complexity of the epidemiology of malaria along the Indian border, some innovative new thinking has to be brought to case classification in Bhutan.
4. WHO should alert the GFATM to allow for re-allocation of funds to meet the priorities identified above.
5. WHO should facilitate information sharing with India across border districts. Partners have committed to working through the platforms of WHO, the Asia-Pacific Malaria Elimination Network (APMEN) and the Asia-Pacific Leaders Malaria Alliance (APLMA) to support information-sharing with Bhutan.

MEOC OVERARCHING RECOMMENDATIONS

Over the course of two and a half days, the MEOC interacted closely with representatives of the national malaria programmes and had several opportunities for in-depth discussions of the challenges facing the programmes. As with the most recent Global Forum of malaria-eliminating countries, the issue of transmission foci that cross international boundaries and the challenge of classifying cases in those areas as indigenous, introduced or imported was a major topic of conversation. The problem of classifying cases in border areas was identified as a key challenge for Bhutan and Timor-Leste, which border India and Indonesia, respectively. For these two countries, development and funding of the 'special intervention zone' concept could be helpful. A related challenge, identified by all countries except Malaysia and Cabo Verde, arises from imported malaria cases coming from neighbouring countries with a higher burden of malaria. In these instances, earmarked support to higher burden countries to address the areas contributing the imported cases could help. Cabo Verde, although an island, remains vulnerable to importation if its receptivity is not well managed. Malaysia, meanwhile, has greater concern over its own citizens who travel abroad for work and may import the parasite when they return. For the former, focused, continued vector control in the most receptive areas will be needed, while for the latter, travellers' clinics and provision of chemoprophylaxis to travellers might reduce rates of importation.

The inclusion of GFATM FPM and M&E officers in the meeting was helpful, as it involved the GFATM staff who make funding decisions in the discussions around programmatic and operational issues that could require reprogramming of existing GFATM grants. The MEOC identified other opportunities for increased engagement with GFATM that could benefit eliminating countries. The MEOC has always recognized the importance of GFATM in elimination, but has been concerned that countries transitioning out of GFATM grants, either due to improvements in their economic status or because they were getting close to elimination, could put countries with high malariogenic potential at risk for resurgences or re-establishment of transmission.

The MEOC developed six overarching recommendations from the focused review meeting:

1. The MEOC recognized the critical importance of GFATM resources in helping many countries to achieve elimination, and made the following observations:

    - It is vitally important to continue to support surveillance and response plans in countries on the verge of elimination, until certification (and beyond) while countries remain receptive and at risk of malaria importation.
    - Funds could be earmarked to higher burden countries that border eliminating countries in order to reduce transmission in cross-border foci. This would be very helpful to the eliminating country. Alternatively, these areas might be considered and funded as 'special intervention zones'.
    - It would be helpful to encourage country coordinating mechanisms (CCMs) with shared borders to enter into formal dialogue.
    - Creating opportunities for WHO to brief members of the Global Fund Technical Review Panel (TRP) and Technical Evaluation Reference Group (TERG) and FPMs on elimination strategies and the challenges of eliminating countries that could be better addressed in Global Fund grants would be helpful.
    - Encouraging catalytic and contingency fund mechanisms available on an emergency basis to address outbreaks could support countries close to elimination that are prone to outbreaks.

2. WHO should advise countries when they are implementing strategies that are not recommended by WHO (e.g., using LLINs and IRS concurrently).

3. The MEOC should study regional initiatives such as the Regional Malaria Elimination Initiative in Mesoamerica to understand how they support elimination.

4. WHO should develop a structured approach to programme auditing.

5. WHO should develop clear and rational criteria for the classification of malaria cases (indigenous, imported, introduced, etc.) by personnel.

6. Through the Chair's annual presentation to MPAC, the MEOC will raise the issues around simian malaria cases and elimination.

MEETING CONCLUSION

The meeting was concluded by Dr Pedro Alonso after a short address by the Chair, Dr Frank Richards, and words of thanks from several of the representatives of national malaria programmes. The MEOC will convene next at the Global Forum of malaria-eliminating countries in June 2019 in Wuxi, China.

Endnote

1. Terms of reference for the MEOC are available here: https://www.who.int/malaria/areas/elimination/meoc-tor.pdf.

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AGENDA

Chair: Frank Richards

TUESDAY, 12 FEBRUARY 2019 – JOHN KNOX CENTER (FLORY ROOM)		
Time	Activity	Speaker
09.00 - 09.15	Welcome and opening of the meeting Introductions Group photo	Pedro Alonso Frank Richards
09.15 - 09.30	Meeting objectives and process	Kim Lindblade
Presentations by Ministries of Health		Facilitators
09.30 - 10.15	Timor-Leste presentation (30') Points of clarification (15')	Tom Burkot Kamini Mendis
10.45 - 11.30	Malaysia presentation (30') Points of clarification (15')	Yongyuth Yuthavong Kevin Marsh
11.30 - 12.15	Bhutan presentation (30') Points of clarification (15')	Kamini Mendis Linhua Tang
13.15 - 14.00	Cabo Verde presentation (30') Points of clarification (15')	Leonardo Simao Rose Leke
14.00 - 14.45	Suriname presentation (30') Points of clarification (15')	Frank Richards Mirta Roses
14.45- 15.30	Belize presentation (30') Points of clarification (15')	Evelyn Ansah Frank Richards
16.00 - 16.45	Costa Rica presentation (30') Points of clarification (15')	Mirta Roses Rose Leke
16.45 - 17.30	MEOC and secretariat only meeting	Frank Richards
WEDNESDAY, 13 FEBRUARY 2019 – JOHN KNOX CENTER		
09.00 - 10.30	**Session 1** - Timor-Leste (Strasbourg room) (17.00 - 18.30 local time) Co-Chairs: Kamini Mendis and Tom Burkot	**Session 2** – Malaysia (Flory room) (16.00 - 17.30 local time) Co-Chairs: Kevin Marsh and Yongyuth Yuthavong
11.00 - 12.30	**Session 3** – Bhutan (Strasbourg room) (16.00 - 17.30 local time) Co-Chairs: Linhua Tang and Kamini Mendis	**Session 4** - Cabo Verde* (Flory room) (09.00 - 10.30 local time) Co-Chairs: Rose Leke and Leonardo Simao
13.30 - 15.00		**Session 5** – Suriname (Flory room) (9:30 - 11:00 local time) Co-Chairs: Mirta Roses and Frank Richards
15.00 – 16:30	**Session 6** – Belize (Strasbourg room) (08:00 - 09:30 local time) Co-Chairs: Frank Richards and Evelyn Ansah	
15.30 – 17:00		**Session 7** - Costa Rica* (Flory room) (08:30 - 10:00 local time) Co-Chairs: Rose Leke and Mirta Roses
THURSDAY, 14 FEBRUARY 2019 – WHO D BUILDING, D23016 (CLOSED SESSION TO MEOC)		
09.00 - 10:30	Development of final recommendations for each country and plan for MEOC involvement	Frank Richards
11.00 - 12.00	Review of the process and overarching recommendations from MEOC	Frank Richards
12.00 - 12.30	Next steps and wrap-up	Kim Lindblade

Report to MPAC, April 11, 2019

Malaria Elimination Oversight Committee

Global **Malaria** Programme

World Health Organization

Background

- MPAC endorsed creation of the independent Malaria Elimination Oversight Committee (MEOC) in March 2017
  - Pillar of the 2015 GTS 'Accelerate efforts toward elimination.'
  - Modelled after similar committees helpful in polio, onchocerciasis and dracunculiasis elimination
- The purpose of the MEOC is to assist those countries close to elimination to achieve that goal
- 10 members selected with public health, malaria or disease elimination experience
  - Mix of high-level political and technical experience
  - 2 adjunct members representing certified countries
- Meetings have been held 3 times since convening

MEOC Terms of Reference

Independent operational and programmatic advice and oversight monitoring of malaria elimination

1. Monitor and report on progress in specific countries according to established milestones and timelines
2. Provide technical advice to address programmatic or operational bottlenecks
3. Identify risks to elimination that need to be addressed
4. Share observations and recommendations with MPAC relating to WHO policies or guidance related to malaria elimination
5. Question the status quo and confront difficult issues

Indepth Review of Countries On Track for Elimination by 2020

- Too many countries at the Global Forum for indepth engagement
- Special meeting held 12-14 February 2019 with focus on 7 countries with <100 cases where extra assistance could be helpful
- Directors of Communicable or Vector-Borne Diseases invited, along with NMCP Manager and surveillance focal point
- Attended by Global Fund fund portfolio managers and monitoring and evaluation specialists

Approach

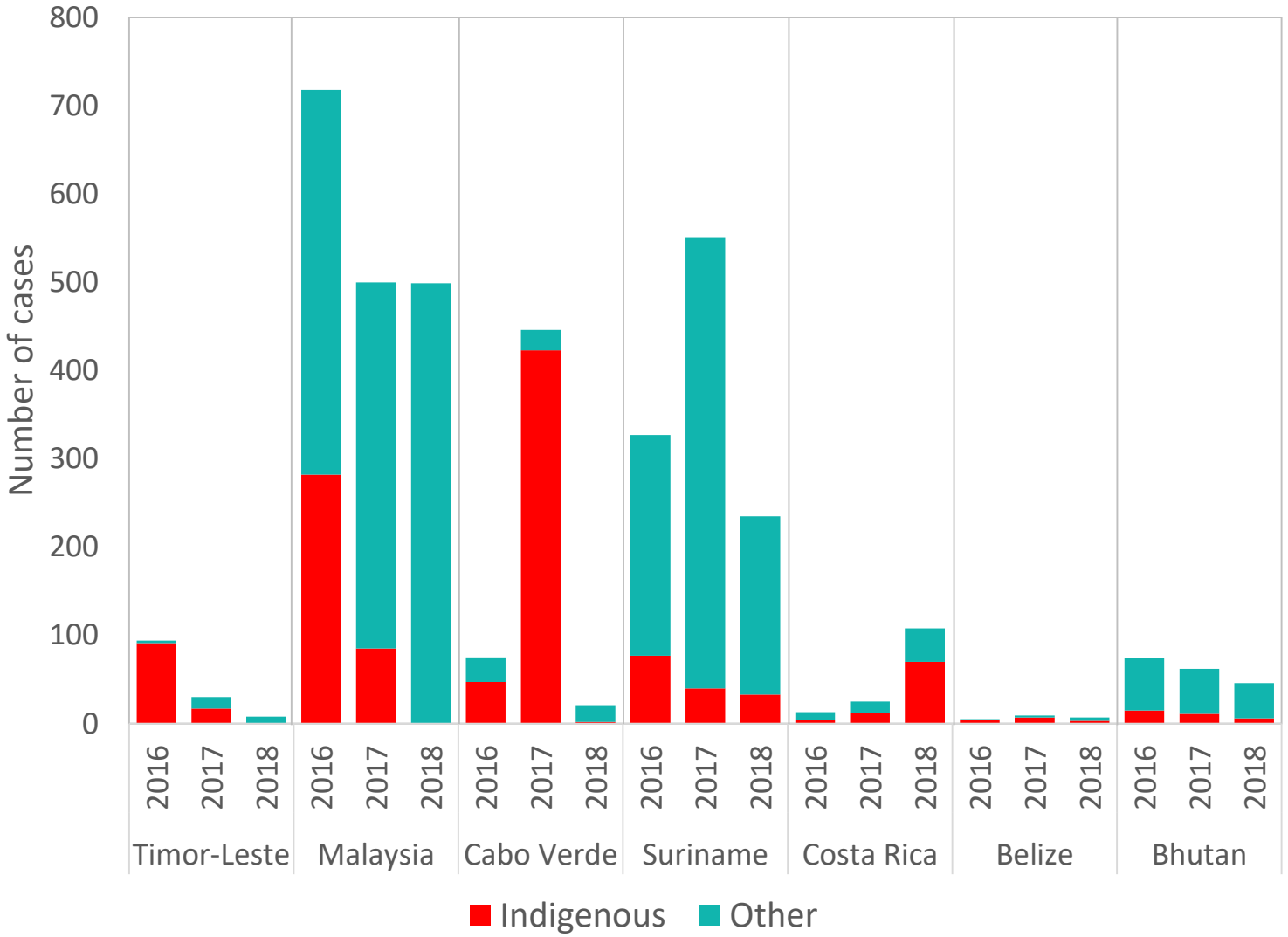
- In advance: countries prepared annual report, translated (as needed) and shared with MEOC
- Day 1: Countries presented on their progress, strategies and challenges in plenary for 30 minutes.
  - Questions were asked by MEOC and others
  - Countries were asked to prepare responses for Day 2
- Day 2: Two-hour parallel sessions with MEOC advisors, WHO and Global Fund
  - Review responses, identify bottlenecks and develop recommendations
  - Final Plenary session
- Day 3: MEOC 'closed' finalization of recommendations

Reduction in indigenous cases by year for 7 countries on-track for 2020

Indigenous cases	2016	2017	2018
Timor Leste	91	17	0
Malaysia	282	85	0
Suriname	77	40	33
Costa Rica	9	13	70
Belize	4	7	3
Bhutan	56	38	34
Cabo Verde	48	423	2
Total	567	623	142

>75% reduction in Indigenous cases in the Group of 7

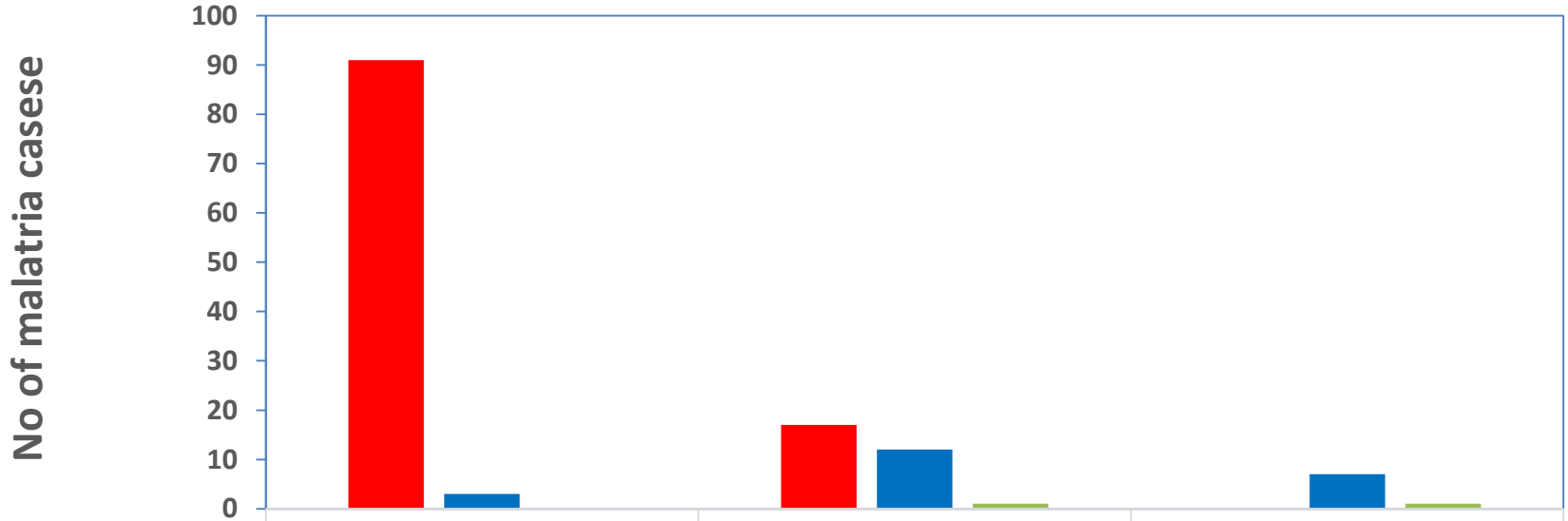
Improvements in 7 countries on-track for 2020



Updates for the seven E-2020 countries on track to eliminate by 2020

Timor-Leste

Number of Confirmed malaria cases of Human Malaria



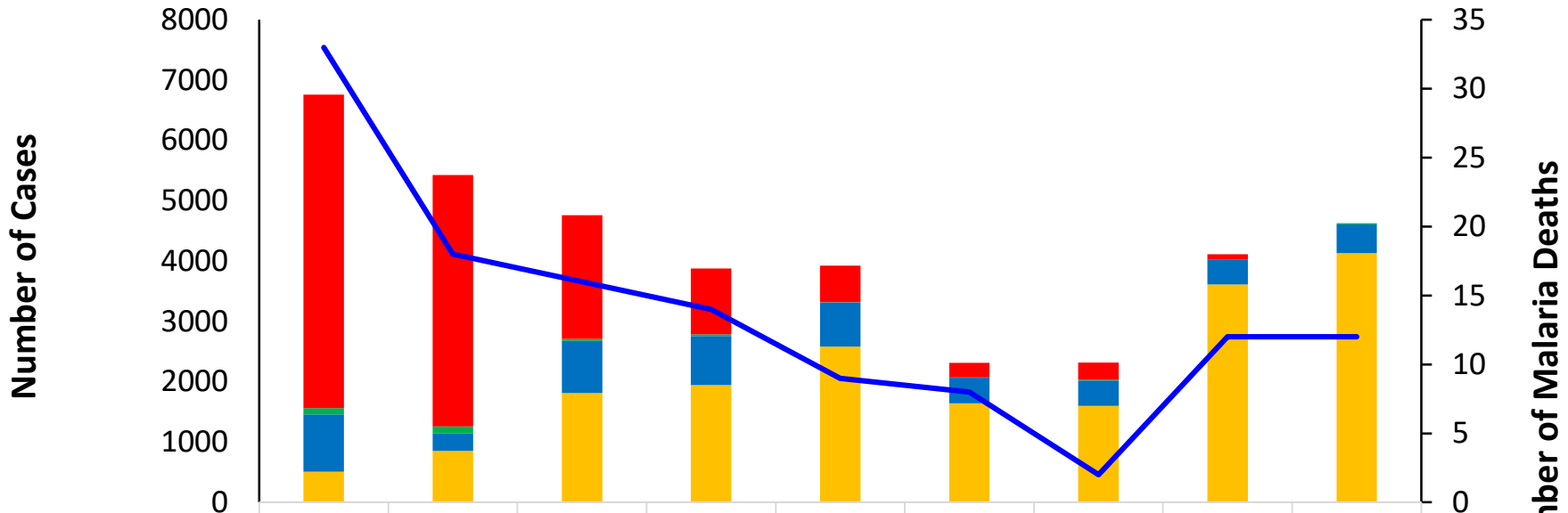
	2016	2017	2018
Indigenous	91	17	0
Imported	3	12	7
Introduced		1	1

Indigenous Imported Introduced

Recommendations to Timor-Leste

- Clearly determine the origin of cases along the porous border with West Timor to differentiate introduced from indigenous cases.
- Continued improvements in collaboration and cooperation in border areas with West Timor should be actively pursued.
- Balance the current elimination efforts with enhancing the overall surveillance and response system, with a view to eventually sustaining elimination status.
- The NMCP should continue to support the private sector both in the diagnosis of malaria and in increasing the proportion of private clinics reporting malaria cases.
- Develop a financial and human resources plan for sustaining interruption of transmission after cessation of the GFATM grant.

Malaysia

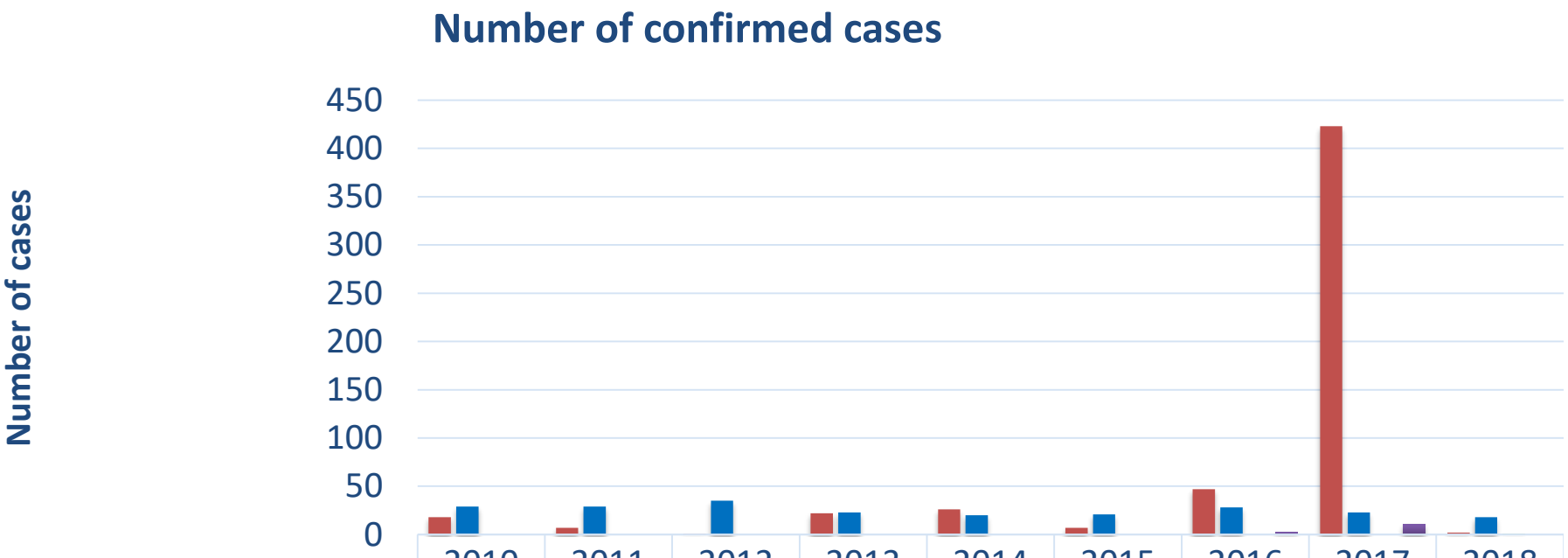


	2010	2011	2012	2013	2014	2015	2016	2017	2018
Indigenous Human Malaria	5194	4164	2050	1092	604	242	282	85	0
Introduced	107	119	33	26	7	3	16	0	21
Imported Human Malaria	947	288	862	816	730	428	420	415	478
Zoonotic malaria (Pk)	509	854	1813	1942	2584	1640	1600	3614	4131
Malaria Death (number)	33	18	16	14	9	8	2	12	12

Recommendations to Malaysia

- *P. knowlesi* challenge needs a specific focus. Two areas for attention are:
  - **development of a communications strategy for (a) target groups, (b) the general public and (c) an international audience;**
  - **development of a specific evidence-based strategy for *P. knowlesi* control.**
- WHO should liaise with senior officials in Malaysia to support the programme, emphasizing three key areas:
  - **reduce turnover of key technical support staff**
  - **maintain financial support for the programme;**
  - **upgrade the surveillance system software to fit the elimination phase.**
- Increase awareness of need for malaria prophylaxis for Malaysians travelling outside the country.
- Increased strategic and coordinated cross-border collaboration
- A structured audit of the malaria programme and its components could be helpful to ensure all aspects are functioning as expected.

Cabo Verde

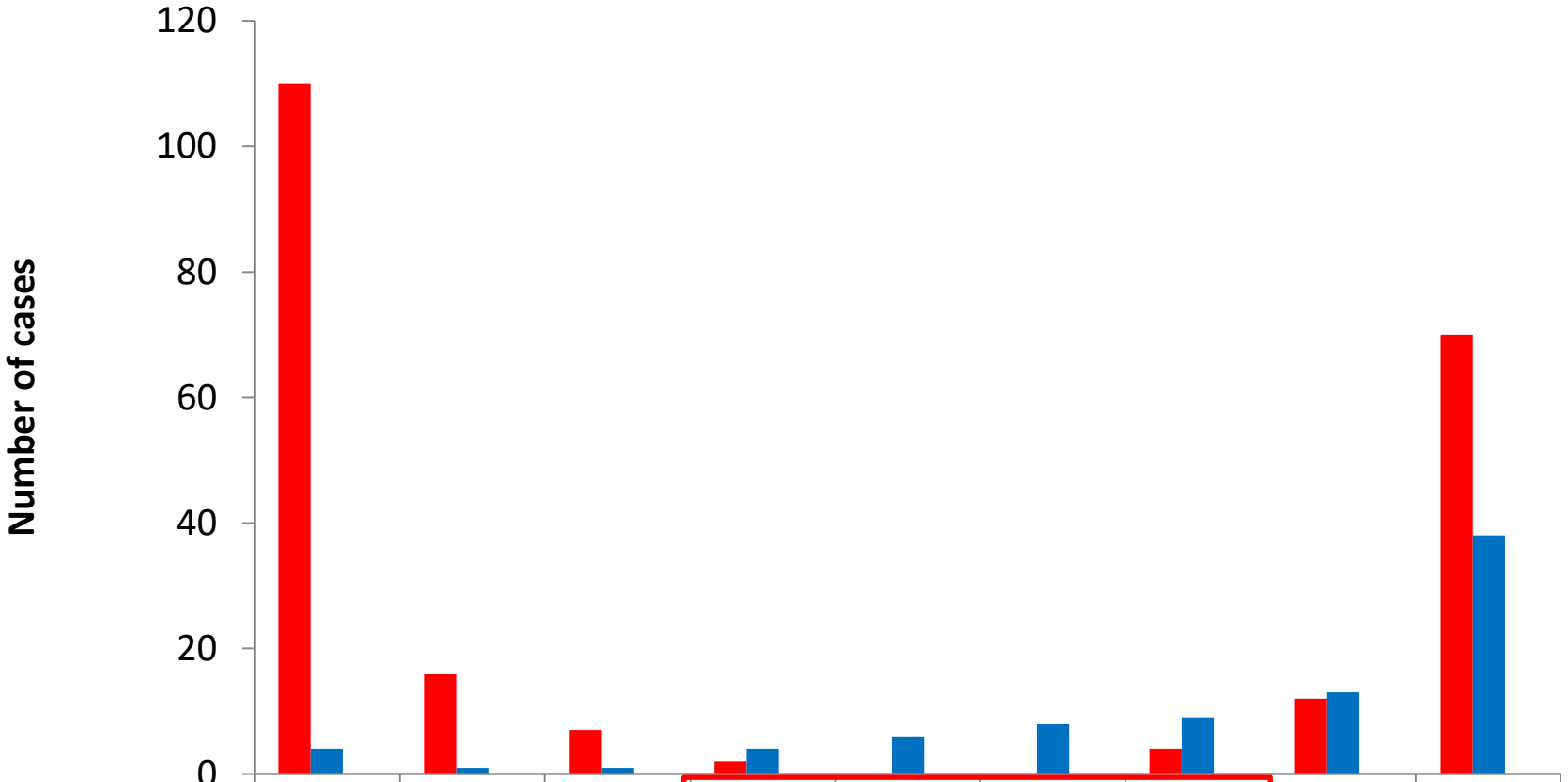


	2010	2011	2012	2013	2014	2015	2016	2017	2018
Autóctono	18	7	1	22	26	7	47	423	2
Importado	29	29	35	23	20	21	28	23	18
Introducido	0	0	0	0	0	0	0	0	1
Recaída/recrudescente	0	0	0	0	0	0	3	11	0

Recommendations to Cabo Verde

- The MEOC commended Cabo Verde for its response to the epidemic
- Significant political will to eliminate exists!
  - **Need to translate the prevailing positive political climate into increased financing, technical improvements and all other components of the programme to ensure the sustainability of the achieved results.**
- Take all necessary steps to keep the country malaria-free and put the national elimination plan into action:
  - **reorient programme mindset and national strategy from control to elimination**
  - **establish active surveillance among migrant populations**
  - **establish an entomological surveillance system**
  - **improve human resources available at all levels of the national programme**
  - **ensure sustainable financing of the programme**

Costa Rica

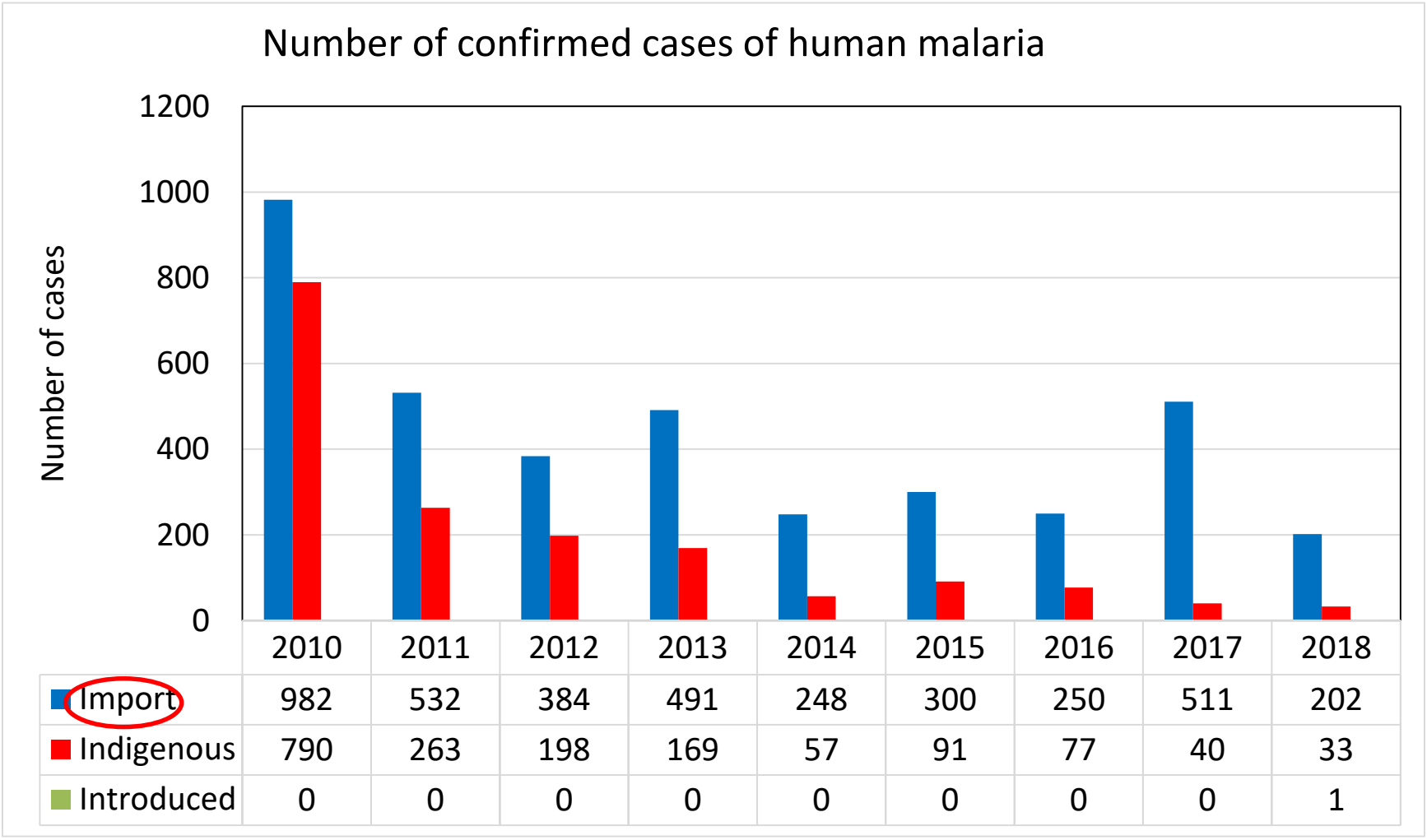


	2010	2011	2012	2013	2014	2015	2016	2017	2018
Indigenous	110	16	7	2	0	0	4	12	70
Imported	4	1	1	4	6	8	9	13	38
Introduced	0	0	0	0	0	0	0	0	0

Recommendations to Costa Rica

- The 2018 outbreak should be documented so that lessons can be learned and similar situations prevented both in Costa Rica and other eliminating countries.
- Strengthen entomological capacity and entomological surveillance should be planned in risk areas.
- Vector control should be implemented in the areas with the greatest malariogenic potential.
- RDTs should be deployed to public health services, particularly in the most vulnerable areas.
- Costa Rica should continue to work in the illegal gold mining communities
  - **detect and treat all cases and prevent any further introduction.**
  - **strengthen intersectoral collaboration with migration, security and local officers.**

Suriname

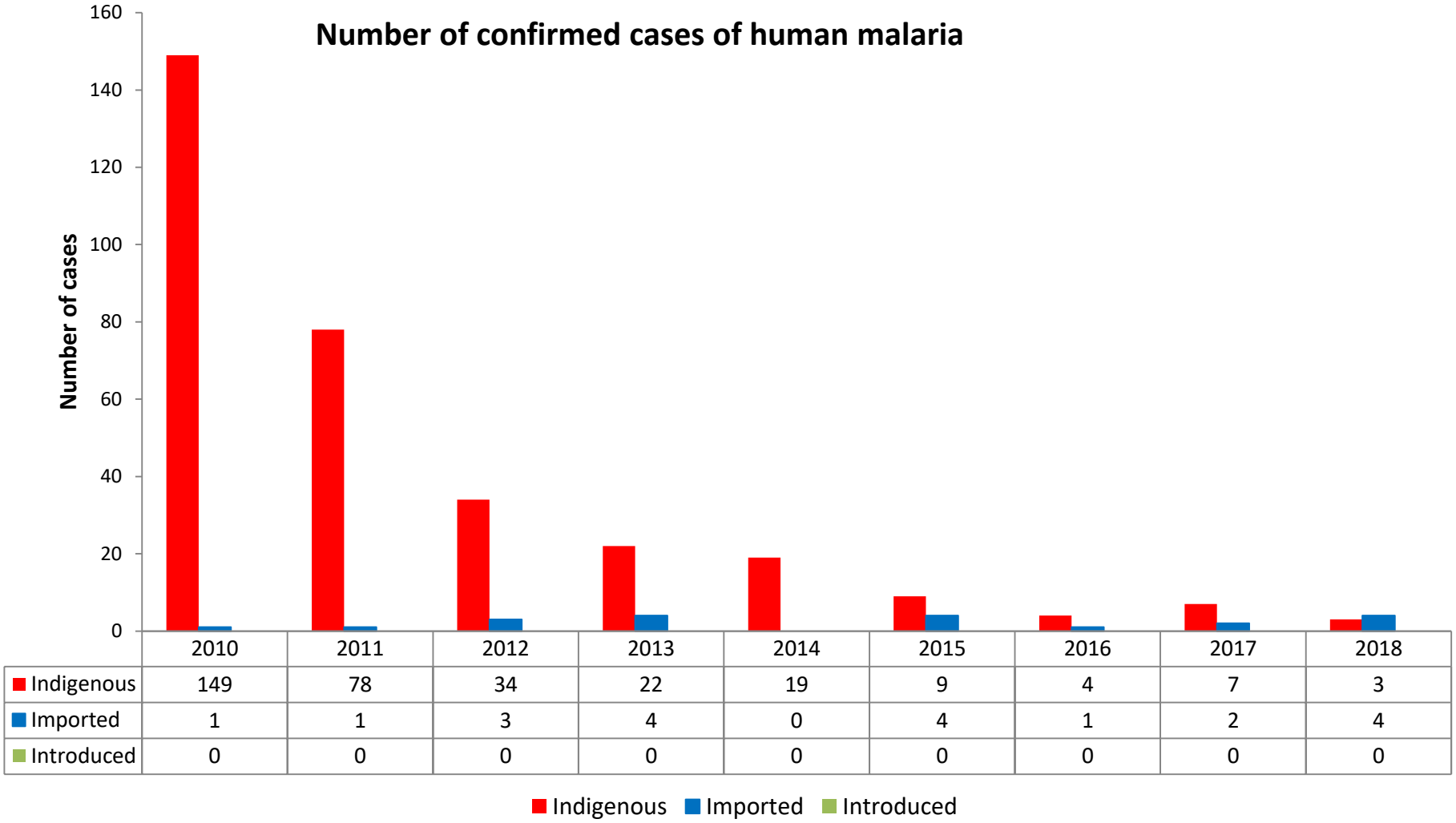


	2010	2011	2012	2013	2014	2015	2016	2017	2018
Import	982	532	384	491	248	300	250	511	202
Indigenous	790	263	198	169	57	91	77	40	33
Introduced	0	0	0	0	0	0	0	0	1

Recommendations to Suriname

- Given the specific challenges in Suriname with cases coming from French Guiana, the programme is urged to identify the minimal essential data on the diagnostic intake form that would allow the correct classification of cases (imported, introduced, indigenous).
- The MEOC commended Suriname for its innovative work in delivering malaria services through border posts and for the pilot project in migrant self-diagnosis and treatment (‘Malakit’) among gold miners.
- Cross-border collaboration with other neighbouring countries (Brazil and Guyana) is needed to tackle the broaders issue of malaria among migrants. Improved information exchange is especially needed between the Guyanese and Surinamese programmes.
- Dependency on external funding needs to be addressed urgently to ensure sustainability.

Belize

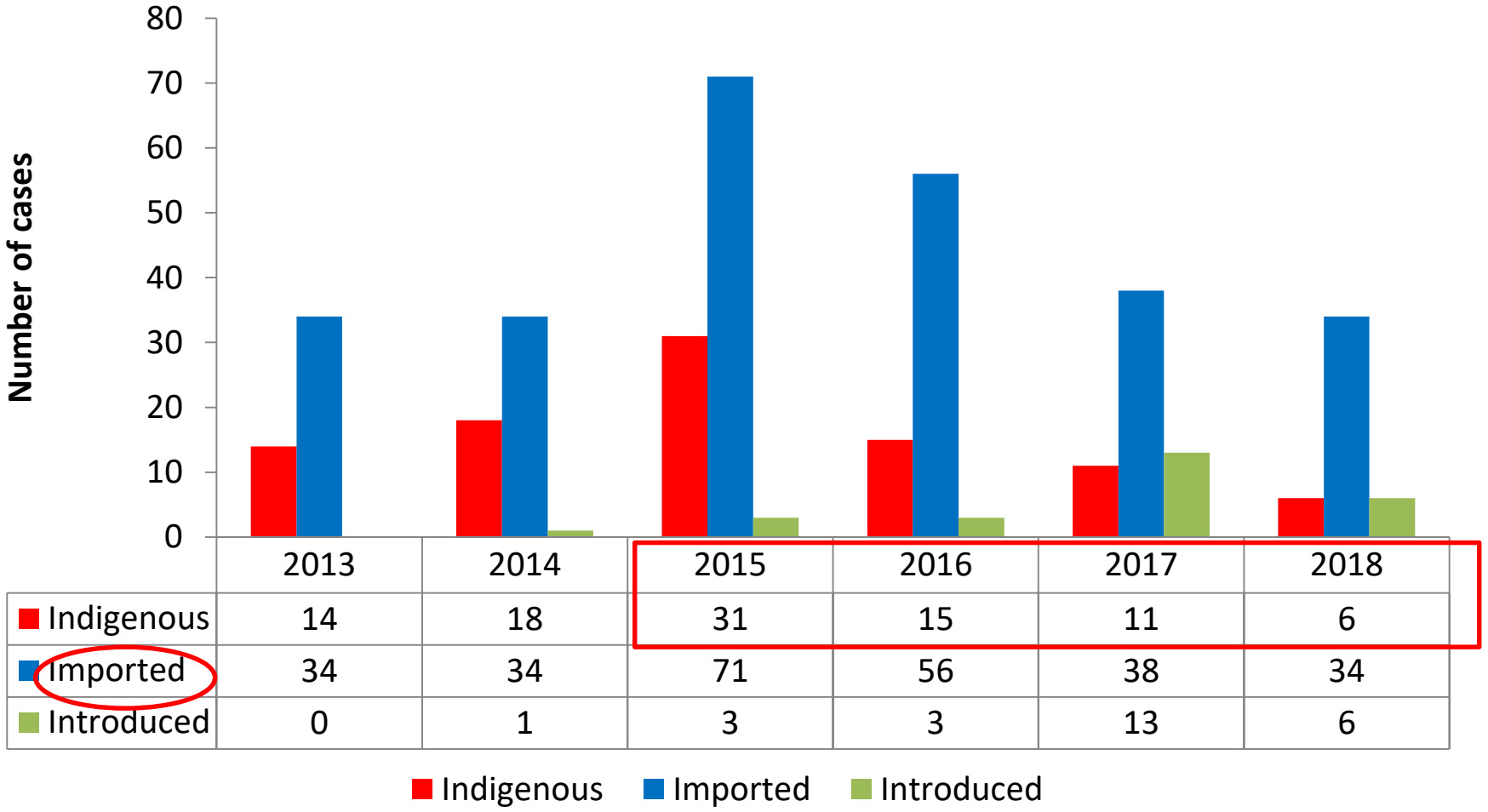


	2010	2011	2012	2013	2014	2015	2016	2017	2018
Indigenous	149	78	34	22	19	9	4	7	3
Imported	1	1	3	4	0	4	1	2	4
Introduced	0	0	0	0	0	0	0	0	0

Recommendations to Belize

- Seek support from PAHO to help with advocacy for the malaria programme at the highest political levels.
- Strengthen the surveillance system (particularly passive) in a sustainable manner, including capacity strengthening of frontline health staff.
- Carry out human resource planning and development and put in place long-term personnel succession plans to ensure availability of the needed trained human resources, e.g., entomologists.
- Continue to invest in efforts to establish cross-border collaboration with Guatemala and Mexico.
- Ensure microscopy skills are maintained and a quality assurance system is in place.
- Implement clear and relevant strategies to reach the mobile and migrant population with screening and services.

Bhutan



	2013	2014	2015	2016	2017	2018
Indigenous	14	18	31	15	11	6
Imported	34	34	71	56	38	34
Introduced	0	1	3	3	13	6

Recommendations to Bhutan

- Field and central level staff are insufficient for effective implementation.
  - **Increase the number of field staff in border districts with India.**
  - **Ensure training at the central level for improved epidemiological analysis and effective use of data.**
- Ensure adequate financing for staff resources and implementation of case and entomological surveillance and response in the border districts.

Overarching recommendations

General recommendations (1)

- WHO should develop a structured approach to programme auditing.
- Through the Chair's annual presentation to MPAC, the MEOC will raise the issues around zoonotic (Simian) malaria cases and elimination in Malaysia.
- WHO should develop clear and rational criteria for the classification of malaria cases (indigenous, imported, introduced, etc.) by personnel.
- WHO should advise countries when they are implementing strategies that are not recommended by WHO (e.g., using LLINs and IRS concurrently).
- The MEOC should study regional initiatives such as the Regional Malaria Elimination Initiative in Mesoamerica to understand how they support elimination.

General recommendations (2)

- The MEOC recognized the critical importance of GFATM resources to help achieve elimination during the 'end game', and made the following observations:
  - **Need to continue to support surveillance and response plans in countries on the verge of elimination, until certification (and beyond) while countries remain receptive and at risk of malaria importation.**
  - **Funds could be earmarked to higher burden countries that border eliminating countries in order to reduce transmission in cross-border foci. Alternatively, these border areas might be considered and funded together as 'special intervention zones'.**
  - **Encourage country coordinating mechanisms (CCMs) with shared borders to enter into formal dialogue.**
  - **Create opportunities for WHO to brief members of the Global Fund Technical Review Panel (TRP) and Technical Evaluation Reference Group (TERG) and FPMs on elimination strategies and the challenges of eliminating countries that could be better addressed in GFATM grants.**
  - **Make catalytic and contingency fund mechanisms available on an emergency basis to rapidly address outbreaks.**

Thank you!

STOP-MALARIA

Stop Transmission of Parasites of Malaria

MPAC

11 April 2019

Dr Kim Lindblade, Elimination Unit

Global **Malaria** Programme

World Health Organization

Challenge: Malaria Elimination's "Last Mile"

- With malaria burden reduced, Ministries of Health refocus to other public health problems
- Complexity increased for achieving elimination:
  - Control: standardized approaches, universal coverage
  - Elimination: complex suspected case definitions, case investigations, focus investigations, response plans
  - Geo-locating of cases to direct investigations and response
- Different skill set required for elimination, but shortage of skilled staff and local capacity may impede or slow progress

Potential Model: STOP-Polio

- 20-year-old WHO-CDC collaboration, part of Global Polio Eradication Initiative
  - Currently more than 250 fellows deployed, 85% African
  - >2100 fellows in 77 countries since 1998
- Fellows on 11-month contracts trained to:
  - track acute flaccid paralysis (AFP)
  - investigate and follow-up AFP cases
  - support national immunisation days
- CDC coordinates recruitment, training and deployment
- Two-week pre-service training in Uganda
- Alumni pursue global health careers, including in malaria

Evaluation of STOP-Polio (2013)

- STOP primarily has significant impact in two areas:
  - Build long-term public health capacity
  - Fill short-term capacity gaps in polio program with direct impact on high priority activities
    - 50% on capacity filling (day-to-day operational issues) and 50% on training/coaching/mentoring
- STOPers perceived to come with high level of motivation and equipped with required technical knowledge
  - Assist in resolving operational issues while educating local staff
- Effective training programme
  - 88% said STOP had a greatly or slightly positive effect on their careers
  - 90% of STOPers joined a public health organization after their assignment (37% NGO, 34% MOH, 15% WHO/UNICEF and 14% private)

Why Launch STOP-Malaria?

- Short- and long-term benefits as per STOP-Polio
- Fellows provide focused, intense support for malaria elimination where it is needed
- Work at local level to build capacity where needs are greatest
- WHO consultant status helps operate more effectively vis-à-vis representing NGO or government
- Builds global cadre of malaria elimination experts

STOP-Malaria Pilot Overview 2019

- Strengthen sub-national technical and operational capacity to eliminate the last foci of transmission
- WHO/CDC 2-3 week training, technical support for fellows and counterparts
- Fellows recruited from among STOP-Polio alumni
  - 250 applications received in February 2019
  - 70 applicants after screening
- Pilot in five E-2020 countries (or neighbours) close to elimination
  - Suriname, Cabo Verde, Bhutan, Pakistan (Iran), southern Africa
- Fellows on WHO non-staff, non-remuneration annual contracts, receive travel and living expenses
- Direct oversight by WHO malaria focal point with technical supervision by WHO regional elimination focal points
  - Specialized technical support from GMP and CDC

STOP-Malaria Training

- Based on new WHO malaria elimination curriculum
- 14 modules plus WHO logistics

Rationale for elimination	Prevention of re-establishment
Principles and goals	Stratification
Epidemiology and transmission dynamics	Innovation and research
Surveillance as an intervention	Management and planning
Diagnostics and case management	Multisectoral collaboration
Vector control	Community engagement
Chemoprevention	Certification

- Practical field exercises
- Additional training in leadership, communication and mentoring

STOP-Malaria Fellows' Activities

- Pairing with local counterpart
- Conduct elimination situation analysis using tools provided by WHO/CDC
- Assist with stratification (at national and/or subnational level)
- Strengthen elimination activities through training, mentoring and direct accompaniment for case and focus investigations and development of response microplans
- Monitor and analyze progress
- Weekly activity reporting

Potential additional components

- Special recruitments for vector control and data managers
- Use of STOPers in subnational elimination in larger countries
- Deployment to support burden reduction in key provinces/districts
- Use of training platform to improve malaria control/elimination skills more broadly

Questions for MPAC

1. Suggestions for improvements to the overall concept?
2. Suggestions for implementation/operationalization to ensure objectives are met?
3. Does MPAC endorse GMP developing and leading this effort?

Thank you

Malaria Policy Advisory Committee Meeting
10–12 April 2019, Geneva, Switzerland
Background document for Session 8

WHO Global Malaria Programme
Stop Transmission of Parasites of Malaria (STOP-Malaria)

Draft concept note
April 2019, Geneva, Switzerland

Background

As national malaria control programmes (NMCPs) successfully reduce malaria burden and begin approaching elimination, the activities and attention of health workers are often refocused to more pressing public health issues. As a result, there is a paradoxical reduction in the attention given to malaria as countries move closer to achieving their goal, which potentially extends the time needed to interrupt transmission. Concurrently, as the malaria burden declines, there is an increase in the complexity of the surveillance and response needs to achieve and maintain a country malaria-free. While control programmes achieve transmission reduction through standardization of approaches and universal coverage, elimination programmes succeed by attending to each individual case, investigating thoroughly the determinants of transmission in foci, and conducting highly focused activities in small areas where transmission persists.

As caseloads are reduced, programmes must reorient their focus to detecting and treating every confirmed case or cluster of cases of malaria. Elimination strategies require data on individual cases that are characterized and classified according to their most likely location of infection. The locations of infections should be geo-located to understand where transmission is occurring. This will direct appropriate investigation to determine the causes of transmission and facilitate appropriate response. Staff at all levels should be trained to examine and evaluate surveillance data on both disease and operations, and to monitor programme progress, target interventions and detect problems that require action. Entomological data should be collected to map receptive areas, inform the case classification process, and develop effective responses. The surveillance system must be sufficiently robust to capture all infections as the number of cases falls and clinical cases and asymptomatic infections are identified. The system must also be sufficiently sophisticated to fully characterize each infection and direct local investigations and clearance of transmission. In sum, malaria elimination programmes, with their requirement for intensive surveillance, focused investigations and tailored responses, must be more nimble and flexible than malaria control programmes and require a different skillset for their human resources.

At present, many countries with elimination goals lack the skilled human resources and experience with surveillance and response to achieve their objective. Updated national elimination guidelines, tools for case-based surveillance, guidance for focus investigations, reliable supervision and monitoring systems, entomological expertise to inform surveillance and response activities, appropriate data management and analysis capacity, and the communications strategies to engage health providers and communities may all be inadequate to attain elimination and approach certification. In addition, countries with ongoing malaria control challenges in certain areas may not

WHO/CDS/GMP/MPAC/2019.02

have the expertise and resources needed to support those subnational areas with malaria elimination goals.

To address the shortage of skilled staff and build such capacity in these countries, WHO's Global Malaria Programme (WHO-GMP), through the WHO regional and country offices, is looking to replicate the successful model of the 20-year-old Stop Transmission of Polio (STOP-Polio) programme, which is part of the Global Polio Eradication Initiative.

WHO believes that short- and long-term benefits will accrue from a STOP-Malaria approach similar to that of STOP-Polio. STOP-Malaria fellows will provide an independent voice to rapidly move elimination activities forward. They will work at the local level where capacity needs are greatest, but they will have the ability to move around more freely in countries as temporary WHO/United Nations staff rather than as private citizens associated with governmental or nongovernmental organizations. Both the receiving countries and the fellows themselves will gain from the collaboration. Fellows will gain invaluable international experience that they can apply to strengthening malaria control and elimination programmes in their countries of origin and/or to working further with global health projects. In these ways, the STOP approach is a unique approach: addressing a public health problem rapidly, building a cadre of international experts in malaria surveillance and response, and strengthening disease surveillance and response at the provincial, district or other subnational level where it is needed the most.

1. The STOP model

The STOP-Polio programme is part of the GPEI, which was launched in 1988 by the World Health Assembly. Many countries have a shortage of skilled public health staff available to fully support polio eradication and other immunization-related efforts. WHO – working in conjunction with national ministries of health – requests skilled, short-term consultants to support immunization programmes by tracking acute flaccid paralysis (AFP), one of the warning signs of possible polio; conducting AFP case investigations and follow-up; and supporting national immunization days. STOP team members are sent on 11-month assignments to support these efforts. The US Centers for Disease Control and Prevention (CDC) provides scientific and technical expertise to GPEI, including coordinating the recruitment, training and deployment of STOP fellows, who are considered WHO consultants once they are deployed in country.

The first STOP team consisted of 25 participants, all of whom were CDC staff members. Over time, citizens from the international community have become increasingly involved in the programme. Current STOP teams are comprised largely of public health professionals from around the world, reflecting the global commitment to polio eradication. In addition, team sizes have grown substantially over the years. Currently, more than 200 participants are deployed during the programme's annual cycle, selected from more than 2000 applicants. While no salary compensation is provided, the programme does support pre-service training in Uganda, travel costs to and within the deployment site, and a daily living allowance. STOP alumni have often been selected for long-term global health assignments, including for malaria programmes.

An evaluation of the STOP-Polio programme in three African countries found the provision of technical knowledge to be an important component of the STOPers' contributions. Equally important, respondents found that STOPers addressed fatigue among local health workers and motivated local staff, provided an external perspective and shared best practices from elsewhere. STOPers were also seen as 'outside the system,' able to bring an objective view and escalate sensitive issues by challenging the status quo.

2. Applying the STOP–Polio model to STOP-Malaria

The STOP-Polio programme provides a successful model for how to channel global expertise in public health, epidemiology and surveillance in a cost-efficient manner to countries that are close to achieving elimination targets and need critical, time-limited support in particular areas of the country. The STOP-Polio programme has proven to be very successful at recruiting well-trained, mid-career professionals who are looking to build experience in global public health. By partnering with CDC to assist with the recruitment and training of STOPers and deploying STOPers in-country under WHO, STOP-Malaria will be able to take advantage of a proven recruitment and deployment system, along with CDC and WHO technical expertise, WHO in-country assistance and supervision, an existing monitoring and evaluation system, and WHO's mandate to support ministries of health.

The provision of extended technical assistance through this proposed programme ("Stop Transmission of Parasites of Malaria" or STOP-Malaria) will contribute field-experienced public health practitioners to provincial, state or district health teams in selected eliminating countries, under the umbrella of the WHO country office, to assist in initiating, implementing, monitoring and evaluating critical malaria elimination activities for which skilled, local expertise may be lacking or insufficient. In addition, the STOP-Malaria experts will be trained in effective mentorship practices and expected to work closely with counterparts to build local knowledge, skills and experience in order to permit mentees to conduct similar activities in the future. Findings from the evaluation of the STOP-Polio programme suggest that ancillary benefits would also likely accrue, including increased motivation of local staff and discovery of new ways to approach old problems.

WHO has already successfully deployed subnational consultants to support malaria elimination in a number of countries. Subnational consultants were deployed in Guatemala, Ecuador and Bhutan in 2017–2018 to support intensive focus investigation and microplanning and reduce malaria transmission in delimited areas. These deployments were received favourably by the countries and provided much needed focus and attention to key geographic areas with established malaria elimination goals.

3. Purpose and objectives of STOP-Malaria

The objectives of STOP-Malaria are to strengthen the subnational technical and operational capacity of malaria-eliminating countries to eliminate the last foci of transmission in the country. The initiative will provide an ongoing source of well-qualified, field-oriented technical staff, trained and monitored jointly by the three levels of WHO and CDC. The initiative will also provide additional training to in-country staff to improve their capacity to eliminate malaria transmission.

4. Innovations to STOP-Malaria

The STOP-Polio programme has been in place for 20 years, and many lessons have been learned over the decades of operation. Several adaptations to improve the model for malaria elimination include:

1. addition of entomology and vector control to the potential competencies of STOPers;
2. inclusion of national malaria programme staff and WHO national programme officers (NPOs) in STOP-Malaria training in order to improve in-country capacity and cover gaps between STOP-Malaria contracts;
3. a comprehensive M&E framework to monitor progress and evaluate impact.

5. Timeline

WHO is launching a pilot STOP-Malaria programme to rapidly roll out subnational assistance to five eliminating countries, while testing the basic approach and administrative requirements and preparing a larger proposal to funders that will be needed for a sustained programme. The first STOP-Malaria fellows will participate in training late in the 3rd or early in the 4th quarter and begin their assignments by October 2019. The timeline in Fig. 1 highlights the major steps in the implementation of the STOP-Malaria pilot programme.

The full proposal for funding of a sustained STOP-Malaria programme will be prepared during the first quarter of 2019 and shared with all stakeholders through a consultative process to ensure open dialogue and feedback.

6. Roles and responsibilities

1. STOP-Malaria fellows

a. Satisfactorily complete required pre-departure training, orientation and administrative requirements.

b. Adhere to all rules, regulations and any other guidelines established by the WHO country office.

c. Submit weekly activity reports by email, prepare technical reports according to the guidelines established by the country office, and submit an end-of-mission report to the WHO Representative and GMP prior to departure from the country.

d. If currently employed, provide confirmation of current supervisor's agreement to allow the team member to participate, without salary reimbursement to the team member's home office.

e. Conduct initial situation analyses to understand the coverage and quality of elimination activities in the assigned area, develop an action plan with counterparts, assist in implementation of action plan, and monitor activities and impact.

2. WHO-GMP

a. Provide overall coordination and management of the STOP-Malaria programme;

b. Coordinate matching of candidates and country placements with CDC and WHO regional and country offices;

c. Provide WHO non-staff, non-remuneration contracts for all STOPers, including health insurance and travel requests authorizing round trip travel between home and training venue and home and duty station.

d. Provide a daily living allowance for the full period of the assignment to cover lodging, meals and miscellaneous incidental expenses while on assignment.

e. Provide a technical and operational team to manage the programme, to include representation from the WHO regional offices.

f. Implement annual training for new STOPers on malaria elimination strategies and activities.

g. Match a headquarters- or regional office-based monitor responsible for technical and operational guidance to STOPers while on assignment.

h. Develop and maintain online activity monitoring application and dashboard to monitor STOPers' activities through weekly reports.

i. Provide funds for agreed in-country activities including in-country orientation and a vehicle rental per assignment country, if needed.

3. National malaria programme

a. Complete the request for a STOP-Malaria fellow in conjunction with the WHO country office.

b. Identify the optimal subnational location(s) for the STOPer.

c. Review and advise on terms of reference for the STOPer.

d. Orient the STOPer to the malaria situation in the country, the national malaria elimination strategy and local malaria epidemiology in the assignment area.

e. Provide an appropriate counterpart to the STOPer in the assignment area.

f. Participate in the performance review of the STOPer.

4. WHO country office

a. Complete the request for a STOP-Malaria fellow in conjunction with the national malaria programme.

b. Release WHO malaria focal point to attend the STOP training during the first year of a STOP-Malaria fellow.

c. Provide in-country orientation to the STOPer to introduce and orient them to the WHO country office, NMCP, elimination partners and specific in-country technical issues.

d. Provide in-country supervision of the STOPer's activities.

e. Flag potential issues or bottlenecks early to the STOP-Malaria technical and operational team for prompt resolution of problems.

f. Work with the NMCP to identify the appropriate subnational location(s) for the STOPer.

g. Agree on the specific terms of reference for the STOPer in country.

h. Facilitate identification of appropriate accommodations.

i. Provide logistical support for transportation and activities.

j. Review STOPer's performance at the end of the tour and recommend renewal of contract.

5. WHO regional office

a. Participate in the technical and operational team to manage the programme.

b. Identify potential assignments for STOPers and introduce the programme to WHO country offices and NMCPs.

c. Participate in the STOP training.

d. Develop and implement a plan to mentor and monitor the STOPer in conjunction with the WHO country office malaria focal point.

e. Provide technical oversight to the STOPer.

6. CDC Malaria Branch

a. Assist WHO in the development and implementation of the pre-deployment training programme.

b. Review CVs, interview candidates and recommend STOPers to WHO based on the agreed list of priority placements.

c. Assist in the development of standard operating procedures and audit tools for the STOPers.

d. Provide a technical and operational team to manage, monitor and evaluate the programme.

e. Lead the evaluation of the impact of the STOP-Malaria programme.

7. CDC Polio Branch

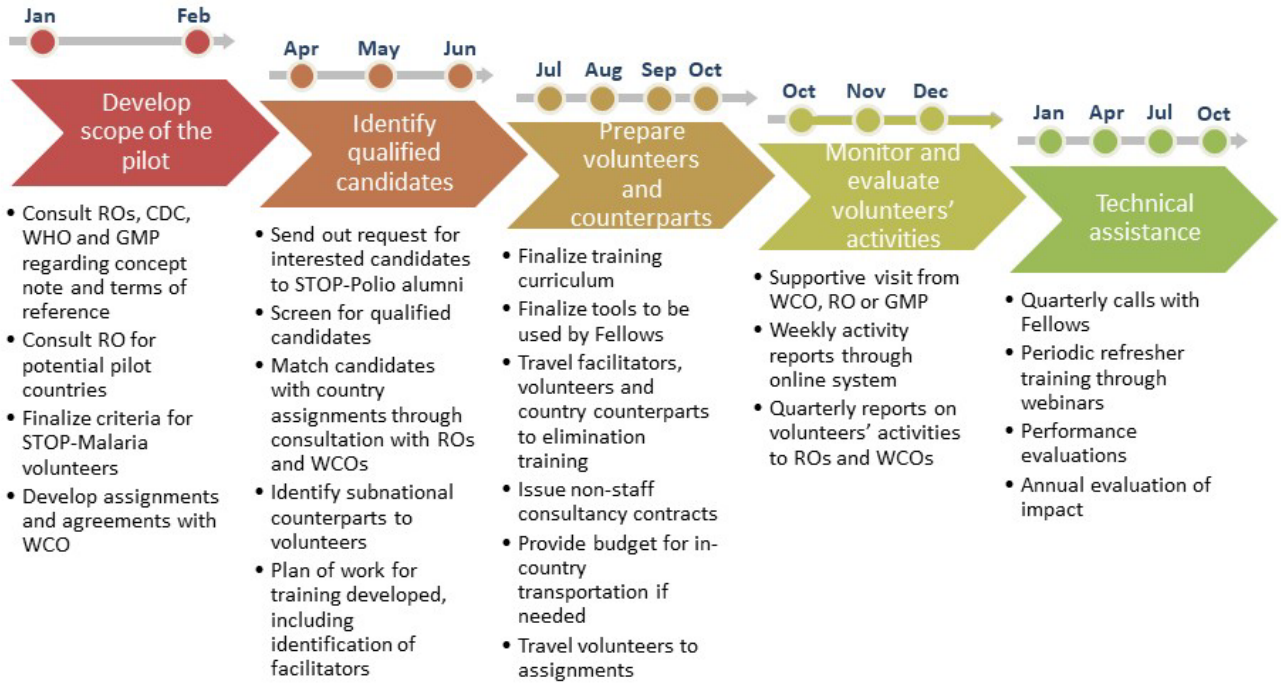
a. Advise on programme strategy development and implementation, drawing from lessons learned from 20 years of STOP-Polio.

b. Provide and manage the system for the advertisement of the STOP-Malaria programme, recruitment of STOPers, review of CVs, interviews and selection of fellows.

c. Advise on developing weekly reporting system and evaluation strategy for STOP-Malaria.

d. Participate in annual evaluations of STOP-Malaria's impact.

Figure 1. Timeline for launching the STOP pilot programme



Abbreviations
RO: WHO regional offices; CDC: US Centers for Disease Control and Prevention; WHO: World Health Organization; GMP: Global Malaria Programme; WCO: WHO country office

Malaria Policy Advisory Committee Meeting
10–12 April 2019, Geneva, Switzerland
Background document for Session 8

World Health Organization

Meeting report of the WHO technical consultation on external competence assessment of malaria microscopists

14–15 January 2019, Geneva, Switzerland

WHO/CDS/GMP/MPAC/2019.07

Contents

Abbreviations

ACTMalaria	Asian Collaborative Training Network for Malaria
ECA	external competence assessment
ECAMM	external competence assessment of malaria microscopists
LQMS	laboratory quality management systems
MDRT	malaria diagnostic refresher training
MoH	ministry of health
NCAMM	national competence assessment of malaria microscopists
NCG	national core group
NGO	nongovernmental organization
NMCP	national malaria control programme
NMPS	no malaria parasites seen
NRL	national reference laboratory
OTSS	outreach training and support supervision
PAHO	Pan American Health Organization
PCR	polymerase chain reaction
QA	quality assurance
RDT	rapid diagnostic test
RITM	Research Institute for Tropical Medicine
RT	refresher training
SEARO	Regional Office for South-East Asia
SOP	standard operating procedure
UCAD	University of Cheikh Anta Diop
WELCOMM	WorldWide E-Learning Course on Malaria Microscopy
WHO	World Health Organization
WPRO	Regional Office for the Western Pacific

1 Introduction

The detection of malaria parasites by light microscopy remains one of the main reference methods for diagnosis of malaria worldwide. It accounts for about half of all laboratory tests performed to confirm malaria infection in clinical settings. The World Health Organization (WHO) recommends quality-assured rapid diagnostic tests (RDTs) and microscopy as the primary diagnostic tools for the confirmation and management of suspected clinical malaria in all epidemiological situations, including areas of low transmission. These tools are recommended because of their high diagnostic performance in detecting clinical malaria, wide availability and relatively low cost. RDTs and microscopy are considered appropriate for routine malaria surveillance of clinical cases in most settings.

There are multiple reports of poor microscopy results in malaria endemic countries as well as in high-income countries where malaria is not present. The diagnostic performance of light microscopy is influenced by multiple factors, including competence of the microscopist in examining blood films for malaria, the supply of reliable equipment and quality reagents, supportive supervision and cross-checking, the workload of the microscopist and the workplace environment. The competence of a microscopist – which is determined by a country's procedures for training, selecting, mentoring and assessing microscopists – plays a major role in the overall efficacy of malaria microscopy. A model for competence assessment of malaria microscopists was initiated by the WHO Regional Office for the Western Pacific (WPRO) in 2006, and was further refined in 2008 to become the WHO external competence assessment of malaria microscopists (ECAMM). The scheme has been successfully implemented in many countries of the WHO Western Pacific, South-East Asia, African and Eastern Mediterranean regions, with over a decade of activities involving participants from 63 malaria endemic countries. To review progress made in this area of work, on 14–15 January 2019, the WHO Global Malaria Programme convened a technical consultation to review updates and provide guidance for the future of ECAMM.

2 Objectives

The WHO technical consultation had four objectives:

1. To review the results of ECAMM workshops conducted since 2009 by multiple institutions, and to evaluate the need for updating the current WHO criteria for certification of competence in relation to detection, species determination and parasite density calculation, including potential impact on certification levels if new criteria are recommended for adoption.
2. To review experiences of the combination of ECAMM workshops with different forms of microscopy refresher training (RT), and to provide guidance on the ideal mix of training plus assessment, as well as recommendations on revised curricula of the pre-ECAMM RT and the ECAMM workshops.
3. To review the variants of malaria microscopy standard operating procedures (SOPs) for slide examination in relation to detection, species determination and parasite density calculation adopted by multiple agencies, taking into consideration the SOPs developed by WHO; the aim being to foster harmonization around common SOPs.
4. To review e-learning platforms recently developed for malaria microscopy and their potential application for RT and self-assessment, in view of the potential wider dissemination and adoption of these learning tools.

3 Review of WHO external competence assessment of malaria microscopists

3.1 Background

Laboratory quality management is needed for laboratories to function efficiently and produce reliable results. Improving laboratory quality leads to more patients being correctly diagnosed in a timely manner, a faster response to public health concerns, less waste of resources and more confidence in laboratory services. WHO promotes the requirements for a laboratory quality management system (LQMS), as formulated in the International Organization for Standardization (ISO) 15189 standard *Medical laboratories – requirements for quality and competence (1)* and in international guidelines, such as the Clinical and Laboratory Standards Institute (CLSI) *Quality management system: a model for laboratory services*. WHO training courses on LQMS as well as training toolkits are available online;[1] they include the LQMS handbook *(2)* and guidance for stepwise implementation of LQMS in accordance with the requirements of ISO 15189, in the form of the laboratory quality stepwise implementation (LQSI) tool *(3)*. Additional resources such as laboratory templates, videos and documents are also available on the WHO website.[2]

The LQMS system considers all elements essential to quality, including organization, personnel, equipment, purchasing and inventory, process control, information management, documents and records, occurrence management, assessment, process improvement, customer service, facilities and safety. In the implementation of an LQMS, the first phase after creating a commitment is to ensure adequate and competent personnel. The activities of external competence assessment and training are essential to ensure adequate and competent personnel and critical elements in the quality assurance of malaria microscopy *(4)*.

The ECAMM scheme was initiated in the Philippines under the coordination of ACTMalaria, and was then expanded to several countries in the WHO Western Pacific and South-East Asia regions, in collaboration with Australia's WHO Collaborating Centre for Malaria. Various course structures were initially trialled in 2005, with different slide compositions and timings; these were reviewed by WHO experts at meetings in 2006 and 2008, to define the assessment model that was implemented in 2009 and is still in use today. The ECAMM scheme was expanded to countries in the WHO African Region in 2009, in collaboration with Amref Health Africa (Amref) (primarily for Anglophone countries) and, more recently, with the University of Cheikh Anta Diop de Dakar (UCAD) (primarily for Francophone countries). The first course implemented in the WHO Eastern Mediterranean Region was in 2016. ACTMalaria coordinated the network from 2005 to 2017, but it is now coordinated by WPRO.

Up to January 2019, 218 ECAMM courses had been held. Since 2015, WHO has completed three workshops to train ECAMM facilitators, to expand the number of facilitators able to run ECAMM workshops at international and national levels; 42 people participated in the training. As a result of this programme, 10 facilitators (seven for the WHO African Region and three for other regions) have been trained and are being mentored, and a further 18 potential facilitators are undergoing training and mentoring.

3.2 Brief description of ECAMM workshops

The standard ECAMM workshop is conducted over five days, with a maximum of 12 people. A pre-ECAMM test assesses participants' knowledge, but does not count towards the final competence level. The pre-test on the first day includes a theory test of 25 questions and a practical examination test of 18 slides for parasite detection, species identification and counting. The following four days involve

[1] See https://www.who.int/ihr/training/laboratory_quality/en/
[2] See https://www.who.int/ihr/capacity-strengthening/laboratory/en/

assessment and revision of various aspects of malaria microscopy and the examination of further test slides.

A total of 56 test slides are examined over three days (Days 2, 3 and 4), as indicated in the ECAMM timetable presented below. Test slides of the four human malaria species (including mixed infections), and in various malaria parasite densities, are used, as well as negative blood slides. All slides used are provided by the WHO malaria slide bank (housed at the Research Institute for Tropical Medicine, Manila, Philippines). They are all confirmed by microscopy and polymerase chain reaction (PCR), and parasite counts on the slides have been validated by certified Level 1 microscopists. *Plasmodium knowlesi* is covered during the course, but is not assessed.

Assessments are performed under "examination" conditions. Participants are given 10 minutes to examine each slide for parasite detection, species identification or parasite counting. The mornings start with a re-examination of the slides examined the previous day, providing an opportunity for open and intensive review, which stimulates learning. A sample timetable is shown in Fig. 1.

Fig. 1. Timetable for ECAMM workshops

Day 1	0800–0915	0935–1010	1010–1300	1400–1430	1430–1700
Mon	Registration, administration, ECAMM structure and expectations	Pre-ECAMM theory test and feedback	Pre-ECAMM practical test (9 slides)	Microscope use and care	Pre-ECAMM practical test (9 slides)
Day 2	**0800–0915**	**0935–1000**	**1000–1300**	**1400–1430**	**1430–1700**
Tue	Review of practice slides	Parasite counting (1)	Test slide examination (10 slides)	Species revision	Test slide examination (9 slides)
Day 3	**0800–0915**	**0935–1015**	**1015–1300**	**1400–1430**	**1430–1700**
Wed	Review of test slides	Parasite counting (2)	Test slide examination (10) slides)	Blood elements and artefacts	Test slide examination (9 slides)
Day 4	**0800–0915**	**0935–1015**	**1015–1300**	**1400–1430**	**1430–1700**
Thur	Review of test slides	QA in malaria laboratory diagnosis	Test slide examination (10 slides)	Training-revision options	Test slide examination (8 slides)
Day 5	**0800–0915**	**0935–1000**	**1000–1030**		
Fri	Review of test slides	Current and future diagnosis	ECAMM evaluation and closing		

QA: quality assurance; ECAMM: external competence assessment of malaria microscopists.

At the end of the course, microscopists are awarded a competence level of one to four with Level 1 being the highest, based on the proportion of correct results in parasite detection, species identification and parasite counting. A breakdown of the achievement required to reach each competence level is shown in Fig. 2. A microscopist has to achieve the required score in all three categories to obtain a competence level – that is, if a microscopist achieves Level 1 for parasite detection and species identification but Level 3 for parasite counting, the overall level achieved will be Level 3. Only Level 1 and 2 microscopists receive a certificate of competence, while Level 3 and 4 microscopists receive a certificate of participation.

Fig. 2. Score requirements to achieve each ECAMM competence level

Competence level	Parasite detection	Species identification	Parasite counting (within 25% of the true count)
Level 1	≥ 90%	≥ 90%	≥ 50%
Level 2	≥ 80%	≥ 80%	≥ 40%
Level 3	≥ 70%	≥ 70%	≥ 30%
Level 4	< 70%	< 70%	< 30%

3.3 Implementation of ECAMM in different regions

3.3.1 WHO Western Pacific and South-East Asia regions: ACTMalaria

A model for the first external competence assessment (ECA) for malaria microscopy, following a similar approach to the approach later described in the WHO external quality assurance manual, was developed and trialled in the Philippines in 2004. In 2005, a bi-regional workshop convened by WPRO and the WHO Regional Office for South-East Asia (SEARO) recommended that ECA courses start at national level for senior 'National Core Group' (NCG) microscopists, in cooperation with national ministries of health (MoHs) and coordinated by ACTMalaria, based on the model developed by the WHO Philippines office. The first countries to have ECA following the bi-regional workshop recommendations were Cambodia (October 2005), Indonesia (October 2005) and Solomon Islands (December 2005). A regional slide bank was initiated in 2007, and in 2008 international training on instructional skills development for malaria microscopy was conducted in Davao City, Philippines. By 2010, all malaria endemic countries in the WHO Western Pacific Region (except the Republic of Korea but including Australia) had been assessed. Quality assurance (QA) of malaria microscopy was included in the agenda of the WPRO programme managers meeting in 2011, after which more countries started to request ECAMM. In 2015, procedures for implementation of ECAMM were reviewed and standardized. SOPs were reviewed and updated, and a regional "Training of trainers for malaria microscopy" course was held, with actual training courses then conducted in 11 countries.

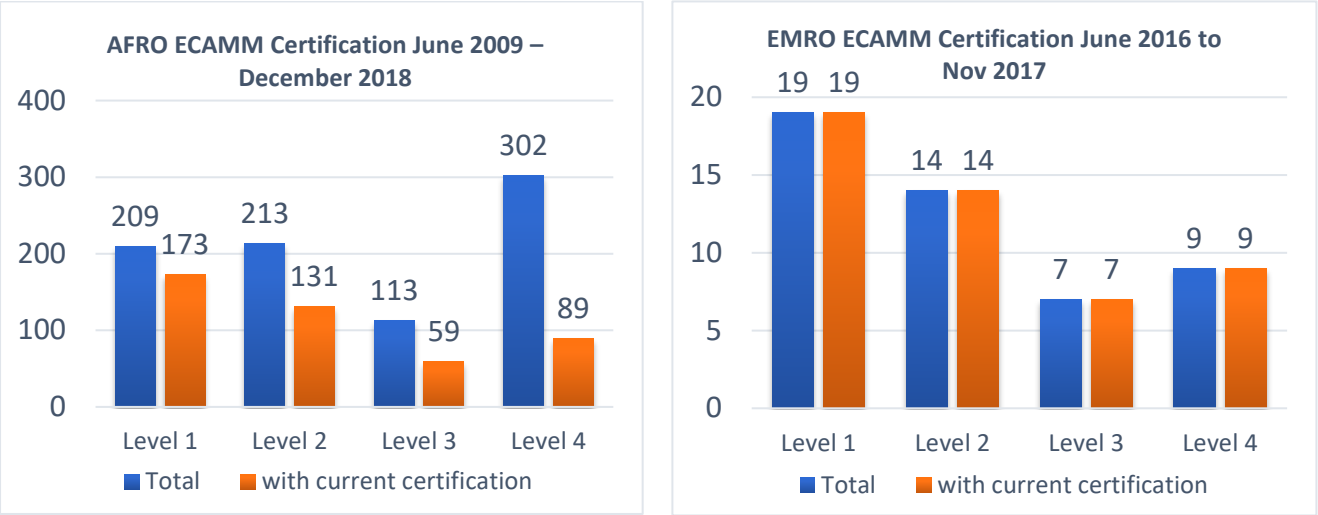
Malaria endemic countries in the WHO Western Pacific Region and South-East Asia Region are now encouraged to set up their own QA management systems; the aim is for all national reference laboratories to have at least one Level 1 microscopist. All countries have participated in multiple ECAMM workshops, and microscopists have been recertified, because certificates have 3 years' validity. Countries are now encouraged not to rely solely on ECAMM for internal certification, but to conduct national training and national competence assessments with certified Level 1 and 2 microscopists as the main facilitators.

3.3.2 African and Eastern Mediterranean regions: Amref Health Africa

Amref Health Africa (Armed started implementing ECAMM workshops in the WHO African Region in 2009, whereas UCAD started implementing workshops in 2015; all of these were implemented with WHO endorsement. To date, a total of 76 courses have been held (64 by Amref and 12 by UCAD), during which 837 microscopists have been assessed (711 by Amref and 138 by UCAD). Four workshops have been held in the WHO Eastern Mediterranean Region, two of which were coordinated by Amref, in Sudan. In total, 49 microscopists have been assessed in the WHO Eastern Mediterranean Region, 24 of them by Amref. Microscopists from 51 countries have been included in ECAMM workshops conducted by Amref. More than 90% of microscopists trained are MoH staff; the remaining 10% are staff from nongovernmental organizations (NGOs) and other institutions.

The number of microscopists assessed by level of competence in each region is shown in Fig. 3.

Fig. 3. Number of microscopists trained at each competence levela



AFRO: WHO African Region; ECAMM: external competence assessment of malaria microscopists; EMRO: WHO Eastern Mediterranean Region; WHO: World Health Organization.

[a] Numbers include individuals who took the course more than once for recertification, or for attainment of a higher certification level.

In the WHO African Region, an electronic marking system was in place from 2009 to 2014, but it was found that this system was too complex, required understanding of formulas and had inbuilt inaccuracies. Since 2015, a manual marking system has been used, with a simplified data entry system. The manual system has been used in all other WHO regions since the start of the ECAMM programme.

There are currently 13 co-facilitators under Amref mentorship, 11 in the WHO African Region and two in the Eastern Mediterranean Region. Two facilitators conduct Amref-led ECAMM workshops in countries of the WHO African Region and in the Eastern Mediterranean Region: one main facilitator and one co-facilitator. However, for ECAMM courses that are not Amref led, or take place in countries in the WHO South-East Asia Region or Western Pacific Region, there is only one facilitator leading the workshop.

3.3.3 WHO Africa Region: UCAD – Senegal

UCAD has eight Level 1 microscopists and three Level 1 facilitators. The Institute of Parasitology at UCAD serves as a reference laboratory for the national malaria control programme (NMCP), and conducts RT and QA or quality control on malaria diagnostics. UCAD also hosts a national and regional slide bank, and performs various methods of PCR and quantitative PCR for slide validation.

Since 2015, UCAD has conducted 12 ECAMM courses, 11 in Dakar and one in Ouagadougou. Seven courses were sponsored by WHO, one by the United States (US) Agency for International Development/President's Malaria Initiative (USAID/PMI) and four by the Senegal NMCP. In total, 138 microscopists from 22 Francophone African countries, including four Portuguese-speaking countries, have attended the courses. Senegal has had the maximum number of attendees (62), followed by Burkina Faso (15) and the Democratic Republic of the Congo (9). Of these attendees, 50 were certified as Level 1, 46 as Level 2, 13 as Level 3 and 29 as Level 4 microscopists. Senegal had the highest number of microscopists achieving Level 1 (23) or Level 2 (27), with most of these being based in Dakar; Burkina Faso and the Democratic Republic of the Congo had 8 microscopists at Level 1 or Level 2, and the other countries had 4 or fewer people at those levels.

In Senegal, there has been an even geographical distribution of Level 1 and 2 microscopists, to help every region have their own competent microscopists and be able to establish their own QA system.

3.3.4 WHO Region of the Americas

The certification scheme implemented by the WHO Region of the Americas – the Pan American Health Organization (PAHO) – is based on RT with theoretical and practical modules (1 week), followed by formal assessment of malaria microscopy competency (1 week). Between 2014 and 2018, four regional ECAMM workshops were implemented by PAHO, in coordination with the Instituto de Diagnostico Y Referencia Epidemiologicos (InDRE, Mexico). In total, 103 participants were trained, of whom 90% obtained Level 1 or Level 2 certification. A total of 90 people have been certified from 23 countries in this region. During 2018, the first recertification workshops were held for the 2014 cohort of microscopists.

The PAHO ECAMM programme follows the general approach of the WHO programme, but with some differences in the competency assessment criteria. The slide sets for testing include only *P. falciparum* and *P. vivax* mono- and mixed infections, although *P. malariae* and *P. knowlesi* slides have recently been borrowed from the Research Institute for Tropical Medicine (RITM) and have been included in the training. In the ECAMM implemented by PAHO, the participants do not know the positivity of the slides on which they perform the parasite count, and they are assessed on parasite stage identification. In addition, the counting criterion is based on a count within ±50% of the true count, whereas the WHO ECAMM is based on a ±25% deviation from the true count, and includes *P. vivax* slides in addition *to P. falciparum* slides. To obtain Level 1 or 2 in a PAHO ECAMM, an average score of 90-100% (Level 1) and 80 -89% (level 2) in the four parameters is required.

3.4 Common challenges in implementing ECAMM courses

Selecting the right participants

Often, those attending ECAMM courses are inappropriate candidates, who are not involved in national microscopy QA programmes. Microscopists who are an integral part of the country microscopy QA system should be selected for ECAMM, and they should contribute (as part of the core team of certified microscopists) to training, certification, and outreach training and support supervision (OTSS) of microscopists in their home countries. To avoid the selection of inappropriate candidates for ECAMM courses, attendees should be selected by the NMCP or the national reference laboratory. Some microscopists are difficult to train because they have a “know it all” attitude and refuse to adhere to instructions given by the facilitators, meaning that they are unlikely to obtain a high certification level.

Recertification

In some countries, it is difficult for microscopists to be recertified after 3 years, because it is difficult to get two opportunities to attend ECAMM when other microscopists have not attended any courses. At the moment, no alternative approach has been developed to reduce costs and make the scheme more accessible.

Facilitator recruitment

It is difficult to recruit, train and mentor suitable ECAMM facilitators; it is also difficult for co-facilitators to become facilitators, because they are required to take leave to attend courses, and often their institute of affiliation does not allow them to attend multiple workshops. The WHO African Region ensures that there are two facilitators at each ECAMM (one facilitator and one co-facilitator) – this is difficult to sustain, even though it provides good opportunities for mentoring of co-facilitators, and other regions have only one facilitator per ECAMM workshop.

Language barriers

ECAMM is most often conducted English, and more recently in French and Arabic; hence, non-Anglophone countries have asked for more translated material. It is important to use technical translators, because the use of non-technical translators may result in inaccurate translations of technical content.

Funding

Financial support for ECAMMs generally comes from WHO and a limited number of funding agencies, but the ideal would be for countries to plan for ECAMM funding in their Global Fund to Fight AIDS, Tuberculosis and Malaria (Global Fund) proposals or other sources of funding. Costs for participants (in the form of tuition fees) could be funded by the malaria programme or funding agencies, whereas the cost for the ECAMM facilitator should be funded by WHO or the agency convening the ECAMM workshops. The institutions implementing ECAMM workshops may be directly funded by different agencies, but ECAMM workshops requiring WHO certification should be coordinated by the WHO regional offices.

Logistical challenges

Some workshops have faced logistical challenges related to last minute procurements of supplies and plane tickets, inappropriate training venues, and negotiating the difficult process of WHO payments to the institutions conducting ECAMMs. From the WHO side, the lack of long-term agreements and the need for new contracts for each ECAMM workshop create extra administrative work; also, there are often delays in signing certificates at the regional offices.

Slide bank

In general, there are few samples of *P. ovale*, *P. malariae* and mixed infections from the WHO slide bank, and a limited number of slides with variable density for counting. Some countries would like to have their own slide banks, but developing and maintaining country-specific slide banks for ECAMM is not cost-effective. Countries should have national slide banks or have access to slide banks for training and for use in malaria microscopy QA activities such as training, national competence assessment, and outreach training and supervision support and proficiency testing.

Standardization and harmonization of procedures

There is a need for procedures to be standardized and harmonized with WHO SOPs, and with other groups and programmes. Some SOPs used in ECAMM (e.g. those for examination of thick and thin blood films and for parasite counting) differ from the WHO SOPs, and from those included in the WHO malaria microscopy training manual and WHO bench aids for malaria microscopy. This variation causes confusion among microscopists, as discussed below.

Pre-ECAMM training

There was a general view that it is a good idea to conduct RT just before ECAMM (although statistical evidence of this benefit is lacking). The impression from many implementing institutions is that holding a week-long RT course 1–2 weeks before the ECAMM greatly improves the competence levels of participants, as discussed below.

4 ECAMM database

In 2018, WHO created a single database that combined the results of 150 ECAMM workshops held between 2009 and June 2018 in multiple regions (except PAHO). Results of individual workshops were maintained in regional databases and, when they were combined, data from a total of 125 ECAMM

workshops were available for statistical analysis. The reasons for exclusion of 25 ECAMM workshops included lack of information on the participants, lack of available reports, lack of answer sheets for individual participants and lack of raw data. The information available in the database includes the following:

- ECAMM information:
    - country in which ECAMM was conducted
    - date of ECAMM
    - name of facilitator
    - reports submitted by facilitator, including raw data (if available)
- microscopist information:
    - country of residence
    - name
    - gender
    - age (at the time of ECAMM)
    - year of previous training
    - level achieved and certificate number
    - answers before ECAMM and in the ECAMM
    - analysis all of results (sensitivity, specificity)

Once finalized, key information in the database on ECAMM workshops (i.e. country, facilitator and date) and participant information (i.e. key demographic information, level achieved and results of ECAMM) will be posted on the WPRO website,[1] and thus will be publicly available. However, full participant information will only be accessible to WHO staff and ECAMM facilitators.

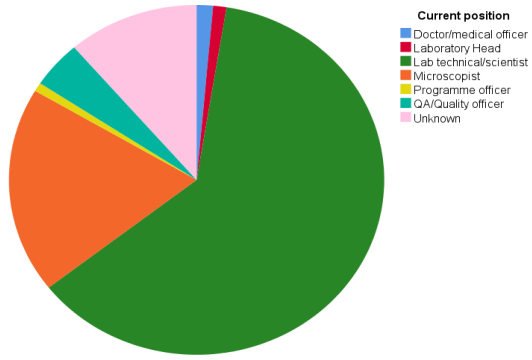
In the database, it is not possible to analyse the data by slide number, to identify the specific slides which participants find difficult or easy to read. The usefulness of the database and relevance of the analysis and interpretation are based on the uniformity of the scoring criteria applied in multiple ECAMM workshops.

5 Analysis of WHO ECAMM workshops from 2009 to 2018

A total of 1485 participants from 59 countries attended 125 workshops conducted between 2009 and June 2018, in 34 countries. The average number of years that the participants had worked in their current position was 13.2 years (range 0–42). Over half of the participants were laboratory technicians or scientists, whereas about one fifth were microscopists (Fig. 4). A total of 88% of participants had attended one ECAMM workshop, whereas 9% had attended two workshops, and 3% had attended three or four workshops.

[1] See https://www.who.int/westernpacific/health-topics/malaria

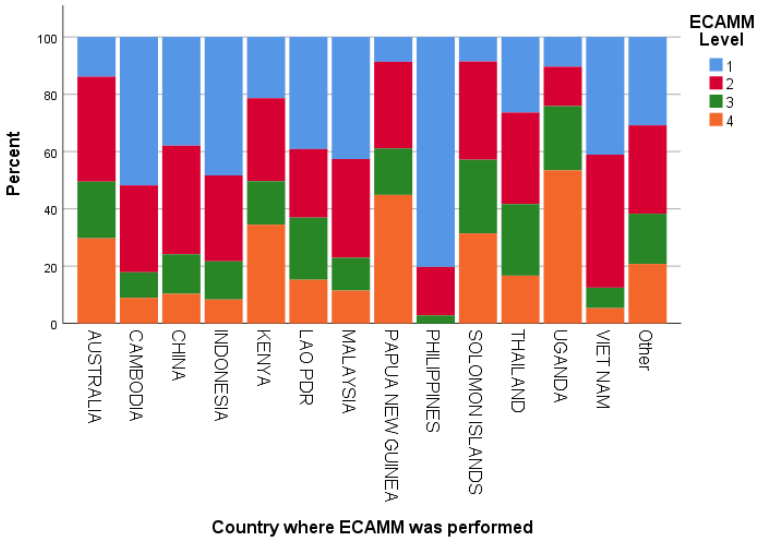
Fig. 4. Pie chart showing the reported current position of ECAMM participants



QA: quality assurance; ECAMM: external competence assessment of malaria microscopists.

Overall, 60% of participants achieved Level 1 or 2, with marked differences in competency levels between workshop locations. The highest proportion of microscopists achieving Level 1 was in those who attended workshops in the Philippines, whereas the lowest proportion was in those who attended workshops in Australia, Papua New Guinea, Uganda and Solomon Islands (Fig. 5).

Fig. 5. Percentage of participants achieving ECAMM Levels 1–4 by country



ECAMM: external competence assessment of malaria microscopists.

Gender and current position were found to be associated with ECAMM level, with females and QA officers being more likely than males and people in other positions to achieve Level 1. A slight but not statistically significant trend associated with age was seen, and there was some evidence (again, not significant) that participants with less than two years of service had lower odds of achieving Level 1. Overall, females aged between 26 and 40 years had the highest odds of achieving Level 1.

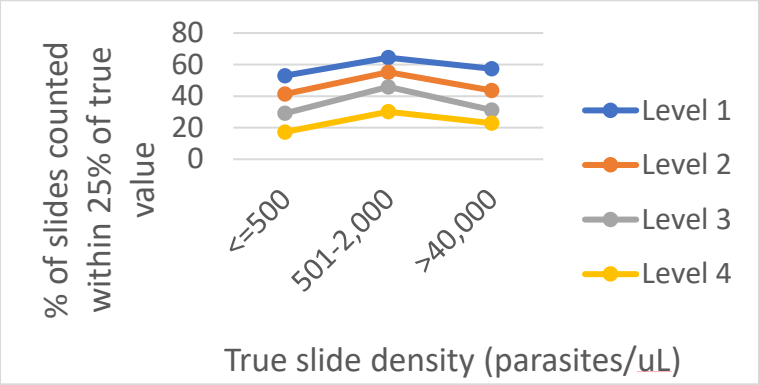
Since 2016, 38% of participants have reported completing WHO RT, with 72% reporting that they completed the RT in the same year as the ECAMM. Although no association was seen between RT and ECAMM competence level achieved, an improvement was seen between the number of ECAMM workshops attended and the competence level achieved, with the biggest improvement seen between the first and second ECAMM.

A significant improvement was seen in the test results before and after ECAMM, in terms of parasite detection (3.1% increase), species identification (16.1% increase) and counting (12.7% increase). Predicting ECAMM level based on pre-ECAMM test results had an accuracy range of 40–49%. The main barriers to achieving a higher ECAMM level were counting (Levels 3 and 4) and species identification (Levels 2 and 3).

5.1 Parasite counting

The highest number of slides that were counted within 25% of the true value was those that had a parasite density of 501–2000 (Fig. 6). This trend was seen at all levels of competence.

Fig. 6. Percentage of slides counted within 25% of the true parasite count, by true slide density



Since 2016, all ECAMM workshops have examined 19, 19 and 18 slides on Days 2, 3 and 4, respectively. Scores in species identification and counting have improved steadily between Days 2 and 4.

A number of errors were made on low-density slides, with 12.2% of parasite densities not matching the results generated using raw data. Many participants appeared to calculate the parasite density using incorrect formulas and therefore obtained the wrong density. Also, in many countries, the use of parasites/µL is not routine (the old system of pluses is still in use); hence, it will take some time for these participants to adjust to the use of parasites/µL.

When comparing participants who received RT with participants who did not receive such training, no association was found between RT and the level of competence achieved. The data do not record the exact contents of the malaria microscopy RT taken, or whether it included species identification covering all species. Also, there is a difference between countries in terms of the content and duration of RT, and in how long before ECAMM the training was conducted. Hence, it was difficult to draw definitive conclusions about the value of RT.

Of particular interest was the performance of microscopists who had undertaken RT in the week before the ECAMM workshop. Dr Gonzales and Dr Gatton undertook to obtain additional data from ECAMM facilitators, to identify ECAMM workshops that were immediately preceded by RT, and reanalyse the data based on this information. This revised analysis indicated that 20% of participants had attended RT in the week before an ECAMM workshop. Although there was a trend for higher ECAMM competence levels for those who had RT immediately before the ECAMM workshop, it did not reach statistical significance. Improved performance of participants attending RT was noted for parasite detection and species identification, but not for counting.

Despite the lack of statistical evidence, most participants in the meeting agreed that, anecdotally and from their own experience, participants who undertook RT before ECAMM performed better than those who did not. It was suggested that, in future, more detailed information should be collected

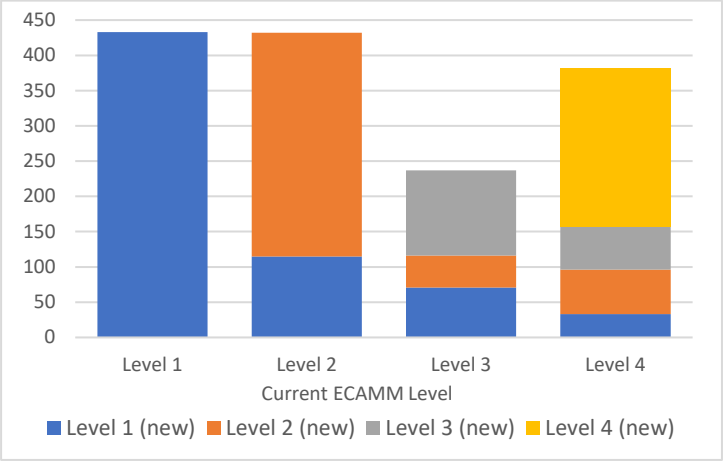
about when participants had RT before their ECAMM course, with a description of the training curriculum in relation to species identification and parasite density quantification.

As part of the ECAMM scoring criteria, two parameters– counting and identifying mixed infections – were reviewed with particular attention. The analysis focused on the effects that specific changes to the scoring scheme would have on the level of competence achieved by ECAMM participants, considering the possibilities listed below.

1. **Parasite quantification cut-off changed from ±25% to ±50% of validated parasite density.**

This would lead to major change, with an overall accuracy increase in counting scores from 44.6% to 68.9%, and 26.6% of participants would achieve a higher ECAMM competency level. Fig. 7 shows the effect of changing the scoring scheme on ECAMM level.

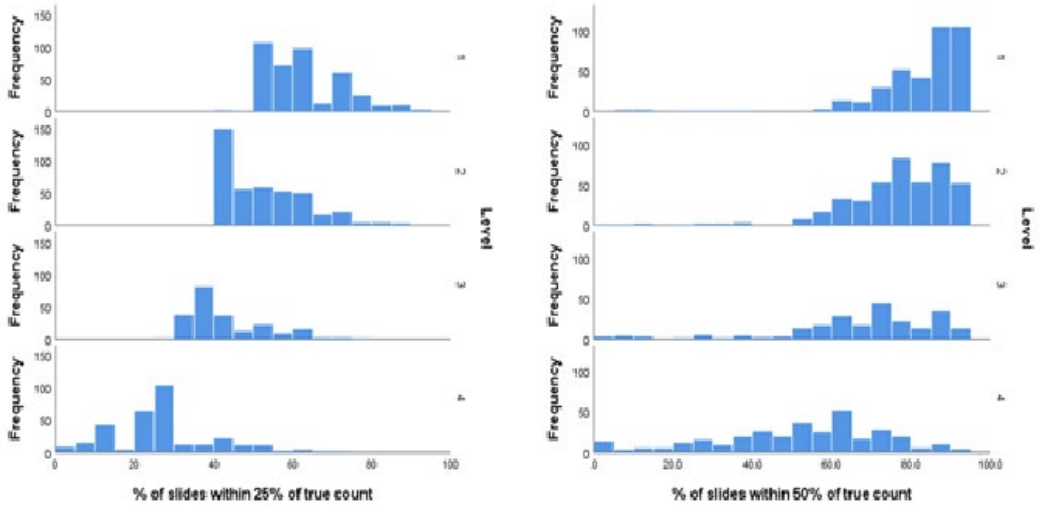
Fig. 7. Effect of changing quantification scoring scheme on level achieved



ECAMM: external competence assessment of malaria microscopists.

Changing the cut-off from ±25% to ±50% of validated parasite density will result in a loss of distinction between the four levels of competence of parasite density calculation, and in high similarities between Levels 1, 2 and 3, as shown in Fig. 8.

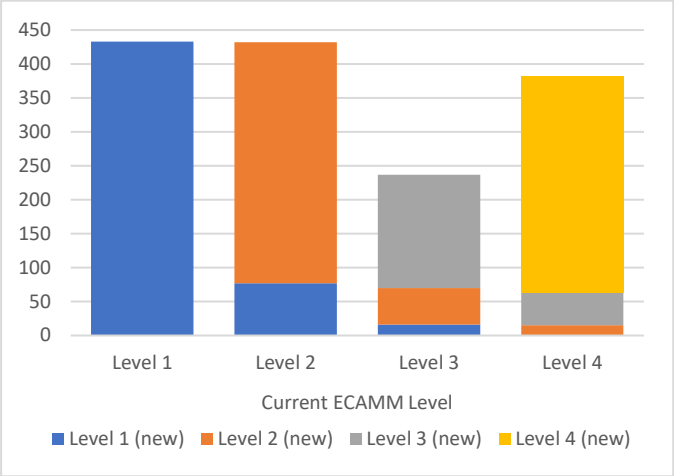
Fig. 8. Distribution of counting scores with 25% and 50% cut-off



2. **Parasite quantification cut-off changed from ±25% to ±50%, but only for slides with lower density infections (200–500 parasites/uL).**

This would result in an increase in counting scores, with 1.2% of participants achieving a higher ECAMM competence level, as shown in Fig. 9.

Fig. 9. Effect of changing quantification scoring scheme of low-density infections on level achieved



ECAMM: external competence assessment of malaria microscopists.

3. **Change in the assessment of species identification for the scoring of mixed infections.**

In the current system for mixed infections, the following scores are applied:

- both species correctly identified = 2
- 1 species correctly identified as single infection = 1
- 2 species identified; one correct and one incorrect = 0
- 2 species identified; both incorrect = 0

An amended scoring scheme may include the following scores:

- both species correctly identified = 2
- 1 species correctly identified as single infection = 1
- 2 species identified; one correct and one incorrect = 1 (change from current scoring)
- 2 species identified; both incorrect = 0

This change would result in increased scores in species identification for 22.2% of participants, but would lead to a relatively minor increase in the scores (a mean increase of 0.24%). The largest increase would be seen in the scores of participants at Level 3 and 4. The changed score would improve ECAMM competence level by one level for 10 (2.9%) Level 4 participants.

The data show that participants sometimes classified single infections as mixed infections, which is currently marked as 0, even if one of the nominated species is the correct species (see current marking scheme above). If the amended scoring system is adopted, it is important that participants do not make "tactical decisions" whereby they only record *P. falciparum* as a single infection, even when *P. falciparum* is present in a mixed infection. Another possible scoring system amendment would be to score an incorrect classification as 0.5 if one species is correct, as presented below; this would mean

that microscopists could be rewarded for identifying a second infection, even if they identify the wrong species.

An additional scoring scheme was devised to avoid this problem; the scheme was as follows:

- both species correctly identified = 1 (change from current scoring)
- 1 species correctly identified as single infection = 0.5 (change from current scoring)
- 2 species identified; one correct and one incorrect = 0.5 (change from current scoring)
- 2 species identified; both incorrect = 0

The rationale behind this new scoring is as follows:

- Complete correct answer = 1
- Each correct species = 0.5
- Identifying that two species are present = 0.5
- Identifying a species incorrectly = –0.5

The result of this proposed change would be, for a *P. falciparum–P. vivax* mixed infection, for example:

- Pf + Pv = 1
- Pf = 0.5
- Pv = 0.5
- Pm = 0
- Po = 0
- Pf + Pm = 0.5 (0.5 for correct Pf + 0.5 for identifying that two species are present – 0.5 for the incorrect Pm)
- Pv + Po = 0.5
- Pm + Po = 0

The application of this new scoring system for mixed infection would change the species identification score for 70.3% of participants; 9.8% would have an increased score while 60.5% would have a decreased score. The average change in species identification score is –0.6% (range –3.7% to 2.5%). This alteration to the species identification score would lead to a decrease in ECAMM competence of one level for 34 (5.9%) of current Level 1, 2 and 3 microscopists, and an increase in competence level of one level for 11 (1.2%) of the Level 4 microscopists.

Participants are told that there are no triple infections in the slides used for ECAMM assessment, to avoid answers with three species. Further analysis from the ECAMM database is presented in Annex 2.

Key findings on analysis of WHO ECAMM workshops

- Overall, changing the scoring criteria of mixed infections would not have a significant impact on the competency level achieved.
- Although it is not possible to have a “perfect” scoring scheme, the agreement was to try a proposed new scoring scheme for mixed infections in ECAMM courses until December 2019, and then reassess.

- The implications of the scoring of mixed infections will depend on clinical relevance, because in many cases the treatment will be the same even if only one of the two species is identified. However, the competent microscopists certified at ECAMM workshops will serve as trainers and may work in clinical efficacy studies and research settings; hence, they must be able to correctly identify mixed infections.
- The data do not show a statistically significant effect of RT on ECAMM score; however, anecdotal evidence suggests a positive impact of conducting RT before ECAMM. Limitations with the dataset (e.g. the differences in timing and contents of RTs conducted in different countries) may be one reason why anecdotal evidence differs from evidence provided by the data.

6 Review of pre-ECAMM RT

6.1 WHO-recommended microscopy training courses

Training courses for malaria microscopy must include theoretical and practical aspects of malaria microscopy; they must also include identification of all four species of malaria at different parasite densities and with parasite counting. As a basic requirement of QA of malaria microscopists, all potential microscopists must first undergo comprehensive basic malaria RT: people with no previous experience have to undertake 5 weeks of training, whereas laboratory technicians with previous experience should attend a minimum 2-week training course.

RT is essential to maintain the competence and motivation of microscopists, and microscopists should attend such training at least once a year (with the training being for at least 1 week if undertaken in preparation for ECA). Retraining should be considered if problems of competence are detected on the basis of slide validation or supervisory visits, and the microscopist should receive additional supervision and mentorship after the training.

Some points about the curriculum for training (basic and refresher) in WPRO countries are that:

- most countries have no standard curriculum or have a curriculum that is not being followed;
- only identification of *P. falciparum* and *P. vivax* is covered, and there is no parasite counting;
- some training uses only PowerPoint presentations;
- blood slides used for training are not validated slides;
- there is no standard system for evaluating participants;
- training is of variable length (e.g. 3–5 days) and, depending on budget, it may or may not include training on RDTs; and
- the number of participants is 15–25 per training.

RT is either one week (with 50 graded slides) or two weeks (with 100 graded slides), incorporating lectures, discussions, and laboratory and practical sessions. Assessment is generally based on scores before and after the training, for practical and theoretical tests (10%) and slide reading (90%). The 2-week course includes more slide reading, and blood slide collection, preparation and staining.

A common challenge is that it is difficult for microscopists to leave their place of work for a long period if training is conducted over two weeks.

6.2 Experience from UCAD

RT involves theoretical and practical sessions, and learning is assessed by tests before and after the training. There are two main formats for the training: a five day curriculum for WHO-sponsored courses, which is conducted immediately before ECAMM, or a two day course for those who are pre-selected. Countries conduct the five day RT about one to two months before attending ECAMM, and the NMCP promotes two-days pre-ECAMM RT immediately before the ECAMM, for microscopists identified during OTSS and malaria diagnostic workshops.

Subjects covered in the training include detection of malaria parasites, species identification, counting of malaria parasites, recognition of artefacts, keeping and storing of examined slides, and recording of results. A total of 56 slides are examined in the five day training, whereas 36 slides are examined in the two day training, with 18 slides read as a pre-training test on Day 1 in both types of RT. Slides used for pre-ECAMM RT are from UCAD, whereas those used for ECAMM are from the WHO malaria slide bank in the Philippines. The RT and the ECAMM workshop are conducted by different facilitators.

6.3 Experience from Amref

At the 27th ECAMM course in 2014, only 15 out of 297 participants (5%) achieved Level 1 certification; therefore, it was recommended that microscopists should adequately prepare before ECAMM. The first pre-ECAMM malaria microscopy RT was conducted in September 2015. Since then, 19 such courses have been conducted, with 236 microscopists trained: 111 (47%) achieved Level 1, 66 (28%) Level 2, 29 (12%) Level 3 and 30 (13%) Level 4.

The RT includes 35 contact hours over five days, with theory and practical sessions. A total of 40 slides are examined during the course. The RT covers blood specimen collection; blood film preparation; staining of blood films; examination and reporting formats; guidelines and SOPs in malaria microscopy; sources of errors in malaria microscopy; waste management; detection, speciation and counting; care of microscopes; and reporting formats.

6.4 Challenges, recommendations and way forward

6.4.1 Challenges

The challenges faced include:

- inadequate funds to support the RT and ECAMM, given that total funding for two weeks is required;
- supplies for wet practicum are sometimes limited or not available;
- there is limited time to cover the content well;
- participants have different knowledge and experience, because the selection criteria for ECAMM are not always adhered to – in particular, training of participants who have low competence before the RT is difficult;
- some participants are difficult to handle (e.g. the person who is a “know it all”), and do not follow the methods taught;
- there may be language barriers, because the RT is taught in English, and translators do not always know technical words; and
- inappropriate venues are sometimes used for assessment, and there are difficulties with transport logistics.

6.4.2 Recommendations and way forward

The following were proposed as recommendations and ways to move forward:

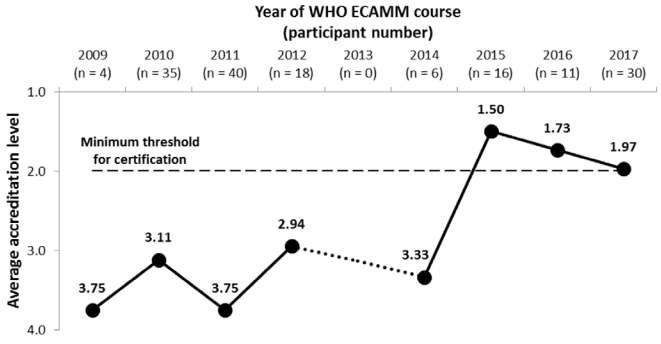
- pre-ECAMM RT should be promoted, to ensure good outcomes and to improve the day-to-day examination of blood slides from patients;
- because it is not possible to cover the content in detail in five days, there is a need for 2-week RT at country level:
    - malaria microscopy RTs need to be practical, to give more time for hands-on learning;
    - access to validated slide banks for all *Plasmodium* species is needed;
    - more bench aids and atlases to support learning are needed;
- malaria microscopy RT content should be available in all languages; and
- the use of e-learning tools may complement workshop-based RT.

7 Introduction of a competency-based selection criterion for the WHO ECAMM: experience from MalariaCare

NMCPs have repeatedly requested guidance on identifying the best qualified candidates for the ECAMM course. Before 2015, most ECAMM participants met existing course entry requirements; that is, they were microscopists working at the national level (national core group or those working in national reference laboratories) who conducted or implemented QA activities *(4)*. However, overall performance was poor, resulting in low certification rates, which in turn led to disappointment at the individual, ministerial and donor levels. Therefore, in 2015, MalariaCare introduced an additional selection criterion based on individual performance during a five-day malaria diagnostic RT course. This RT included a theory-based test and practical tests, and three days of learning and daily assessments.

Before 2015, selection criteria for microscopists to attend ECAMM were based not on competence, but on current position and on having a laboratory background. The new criteria were introduced in 2015, when the guidelines changed and competence became a selection criterion; since then, the average certification level has surpassed the minimum threshold for certification and has stayed above this level (Fig. 10).

Fig. 10. Average RT level achieved by year



RT: refresher training; WHO: World Health Organization; ECAMM: external competence assessment of malaria microscopists.

A two-step process for selecting candidates for ECAMM was then established, based on:

- role in the NMCP; and
- completion and passing of the malaria diagnostic RT with Level A or B (equivalent to Level 1 or 2 ECAMM competence).

The ECAMM participants who met course entry requirements but were not pre-screened (i.e. before the 2015 guidelines) (n=106) were compared with those who were screened (2015 onwards) based on a five-day RT course (n=54). For each ECAMM test component, microscopists selected through the competence-based screening outperformed their unscreened counterparts. Before 2015, 81 of 106 (76.4%) participants achieved Level 3 or 4 and were not certified, compared with 8 of 54 (14.8%) after 2015 (Fig. 11). A chi-square test of independence was performed to examine the relationship between competence screening and attaining Level 1 or 2 certification. The relationship between these variables was significant ($P < 0.001$). Competence screening was not independent of course outcome (attainment of Level 1 or 2 status). From logistic regression analysis, competence-screened microscopists participating in WHO ECAMM had 18.63 higher odds of attaining Level 1 or 2 WHO certification than unscreened participants.

Fig. 11. Percentage of participants achieving each microscopy level, by screened and unscreened participants

WHO certification level	All participants (N = 160)		Unscreened participants (n = 106)		Competency-screened participants (n = 54)	
	n	%	n	%	n	%
Level 1 (Expert)	32	20.0%	9	8.5%	23	42.6%
Level 2	39	24.4%	16	15.1%	23	42.6%
Level 3	17	10.6%	14	13.2%	3	5.6%
Level 4	72	45.0%	67	63.2%	5	9.3%

WHO: World Health Organization.

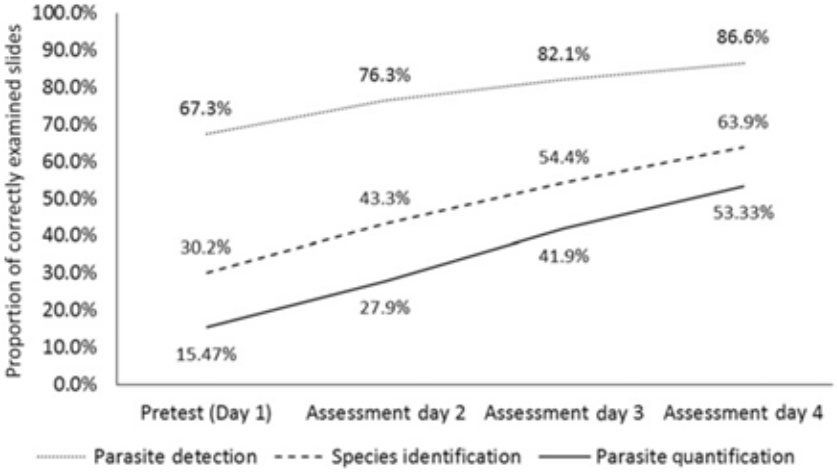
Existing course entry requirements, when used as an initial selection tool and paired with competence-based screening, may serve as a robust method for identifying candidates for WHO ECAMM courses. The malaria diagnostic RT (MDRT) was offered to host-country nationals working at central, regional and peripheral levels of the health system. The aim was to emphasize RT to improve skills; the training was not an assessment in itself. Participants with outstanding performance were selected and sponsored to attend ECAMM.

7.1 Findings from Africa-based RT

Findings from Africa-based MDRT have been published *(5)*; they include person-level and slide-level analysis. The analysis included results from 817 participants from 45 MDRT courses across nine countries (Democratic Republic of the Congo, Ghana, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique and United Republic of Tanzania). A total of 981 slides, read 26 345 times, were used; they included 522 negative slides for parasite detection scores, and 571 slides for assessing parasite quantification skills.

Among the participants, 11% achieved Level A or B in all three categories (parasite detection, species identification and counting). Positive trends were seen for each RT challenge given at different days, showing continued improvement throughout the course (Fig. 12).

Fig. 12. Proportion of correctly examined slides by assessment day and challenge type



Across all participants, differences in mean scores from the pre-RT test to the assessment on Day 4 were positive and statistically significant ($P < 0.001$) for each competence level within each challenge and overall (Fig. 13). The proportion of participants attaining Level A for parasite detection increased from 17.1% to 57.9% from the pre-RT test to Day 4.

Fig. 13. Average participant scores by assessment day, competence level and challenge type

	Pretest (Day 1)	Assessment Day 2	Assessment Day 3	Assessment Day 4	Pretest vs. Assessment Day 4
	Mean (SD), %	Mean (SD), %	Mean (SD), %	Mean (SD), %	Difference in mean scores, %
All Participants (N=817)					
Parasite Detection	67.3 (19.3)	***76.7 (16.4)	***82.2 (15.1)	***86.5 (14.6)	***19.1
Species Identification	30.7 (21.9)	***43.7 (26.0)	***56.0 (24.8)	***65.6 (26.1)	***34.9
Parasite Quantification	15.5 (20.6)	***28.4 (27.1)	***41.2 (29.0)	***53.6 (31.7)	***38.2

*** denotes $P < 0.001$

SD: standard deviation.

Key findings on introduction of a competency-based selection criterion

- Analysis of 45 RT courses conducted before ECAMM in nine African countries showed that this approach significantly improved the competence level achieved for each challenge.
- Performance increased steadily from Day 1 to Day 4 of RT for each challenge. Based on these data, to minimize the effect of progressive improvement in competence levels over the duration of the ECAMM, it was suggested that the slides assessment for ECAMM be started on Day 3, after teaching and practice on species identification and parasite density calculation.
- Currently, different institutions are using a different number of slides and different structures of RT; hence, it was suggested that the content be standardized across regions.
- There may be a need to evaluate the potential role of RT in selecting good potential candidates for ECAMM or in preparing selected candidates for ECAMM, or for both applications.

8 Review of malaria microscopy e-learning tools

The consultation reviewed a few e-learning tools applied to malaria microscopy; these tools are designed to complement workshop-based training, and to compensate for some of the shortcomings of conventional training courses. Such tools are needed because of limitations in the current training; examples of limitations are as follows:

- Most training courses require instructors with decades of experience to transfer their expertise to laboratory personnel in 1–2 weeks.
- Some training courses use visual aids and illustrations that are generally of ideal or idealized type specimens that are seldom seen in the laboratory, rather than presenting the extreme morphological variability of the malaria parasites – this is a great source of frustration for inexperienced microscopists.
- Teaching aids do not always include identification or explanation of artefacts, "pseudo-parasites" or non-malaria pathogens, and there are difficulties in recognizing the parasites when the quality of blood film preparation and staining is poor.
- Slide banks, although ideal, are fragile and thus difficult to transport, and difficult and expensive to establish and maintain; also, slide banks are not interactive, their colours fade with time, and mounting media eventually dry and crack. For demonstration purposes, it is impractical to search through a slide bank for assistance in identifying unusual or unknown specimens – it is more productive to go through a collection of reference images.

E-learning tools could improve competence and address some of the challenges in RT of malaria microscopists. In particular, the remote location of most microscopists, and the costs and difficulties involved in leaving the workplace to attend training, could be compensated for by having training tools that are accessible at all times. Such tools are intended to complement rather than replace workshop-based training – they are intended for self-learning as part of RT. The examples discussed here are a CD-ROM on microscopic diagnosis of malaria and the WorldWide E-Learning Course on Malaria Microscopy (WELCOMM).

8.1 CD-ROM on microscopic diagnosis of malaria

A CD-ROM was developed by the US Centers for Disease Control and Prevention (CDC), Atlanta, with technical contribution from an independent group of experts convened by WHO. The aim is to improve competence in confirming malaria infection with optical microscopy, and the CD is intended for

microscopists, laboratory technicians and trainers involved in teaching malaria microscopy in endemic countries and in malaria-free countries. The CD is designed as a training aid for use by an instructor in a classroom setting or for self-instruction, and it contains photos of microscopy of human malaria parasites as well as resource documents. The CD can be downloaded as a single complete file or in two parts,[1] and it is distributed with hard copies of the WHO's *Basic malaria microscopy – Part I: learner's guide (6)*.

The CD is designed to strengthen the malaria diagnostic competencies of laboratory technicians, and it can be used in a classroom as a training support tool or for self-learning. It helps users to identify the four human malaria species and the various growth stages of parasites visible through microscopic examination, and to distinguish between trophozoites, schizonts, and gametocytes in both thin film and thick film preparations. It is also useful for detecting artefacts, contaminants and other blood parasites in stained films; recognizing the causes of colour variations in stained films; and differentiating species in mixed infections.

The CD includes more than 430 micro-photographs of routine malaria thin and thick blood slides stained in the field, and 80 "test slides" grouped in four different levels of increasing difficulty, to assess competence. It also includes four *P. falciparum* images of placenta smears, rarely seen forms of *P. vivax*, and images of other blood pathogens and parasite stages seen in infected mosquitoes. The CD provides ready access to a rich set of malaria microscopy "real-life" images, in an image library that is well organized by species, parasite stages, and thin and thick film preparations. There is also the potential to use the images in the CD to teach quantitative diagnosis.

8.2 WELCOMM

WELCOMM is an e-learning tool that was developed by Amref and Global Good/Intellectual Ventures Laboratory; the curriculum was developed and piloted in 2015. A review workshop and a second pilot were conducted in 2016, and amendments made with the conversion to an e-learning tool. A second review workshop was held in 2017, followed by a pilot conducted in the Philippines. Final amendments were made in 2018, and the full roll-out is planned for 2019.

The WELCOMM course has tests for before and after RT, and it is divided into five modules, covering:

- global malaria overview and life cycle
- blood collection, preparation and staining of blood films
- blood film examination
- non-microscopic methods of detecting malaria parasites; and
- LQMSs.

The WELCOMM course will be available on a USB drive, meaning that it can be used even where there is no Internet access, and the process for enrolment will be posted on the Amref and Amref International University websites. It includes the use of an innovative virtual microscope, which simulates slide examination with a microscope, and it has video clips on blood preparation and training. All training is consistent with WHO malaria microscopy training SOPs.

WELCOMM includes a final assessment and demand for certification that can be submitted online when Internet access is available. Participants may ask to be certified by Amref International University – they receive a final assessment access code (for multiple choice questions and microscope slide evaluation) and, after obtaining a passing score, they receive a certificate of achievement.

Amref has introduced WELCOMM at different prices at individual or institutional levels, based on World Bank country economic status of the requesting individuals or institutions. Prices for the course

[1] See https://www.who.int/malaria/areas/diagnosis/microscopy_cd_rom/en/

and certification for individuals range from US$ 100 to US$ 350, and for institutions from US$ 4000 in low-income countries to US$ 20 000 in high-income countries. The aim of the pricing scheme is not to rely on donor funding, but to have a sustainable system supported by the fees of participants and institutions taking the course.

To date, 214 people have completed the online course, mainly from United Nations Level 1 clinics (137 participants from 25 countries). Sixty people from the Elimination 8 Secretariat have completed the course, and others have come from universities and independent labs. There have been several requests for copies for training in laboratories, but the nature and purpose of these need more clarification.

There have been requests to translate WELCOMM into other languages (e.g. Arabic, French, Spanish and languages for countries in the Greater Mekong subregion) and to add an online support system. The programme currently only works on Windows PC-compatible computers, but there are plans to configure it to work also on Macintosh operating systems.

Key findings on review of malaria microscopy e-learning tools

- E-learning tools remain an adjunct to training rather than an alternative to hands-on training. Their principal limitation is the requirement for access to a computer and projection equipment for group learning, and the lack of real-life training on manual microscope use and slide preparation. The module format available should be sufficiently accessible to enable modifications, additions and language translations, and can easily be updated; it is also affordable. The module can be used as a teaching practice tool to help identify trainees with potential for promotion to trainers.
- Training courses seldom deal with interactions between patients and laboratory personnel. The usual diagrammatic sequence of the diagnostic process is sample collection, blood film preparation, slide examination, recording and reporting, with the patient being represented by a finger. However, the diagnostic process should *begin* with the patient. Courtesy, care for the patient's safety and explanation of the procedure help in gaining patient cooperation, especially with infants and children. Courses should emphasize the three Rs: *respect* the patient, *respect* the equipment and *respect* the protocols.
- Testing supplies should be arranged on the laboratory bench in order of use to save time, and to show participants how to reduce contamination and exposure to occupants. A resource for information on new diagnostic procedures or modifications would be valuable.

9 Harmonization of malaria microscopy SOPs

Since 2017, ECAMM facilitators and participants have become increasingly concerned about the different WHO SOPs on slide examination by microscopy; for example, those presented in different WHO documents – such as those on SOPs for malaria microscopy *(7)*, and on bench aids *(8)* – and those used in the WHO ECAMM workshops. Possible solutions include aligning both sets of SOPs either to WHO SOPs or to ECAMM SOPs, or agreeing to have two separate sets of SOPs. Four points of divergence were identified and are discussed below.

9.1 Thick film examination

A. Should the scanning of the thick film be done by examination of contiguous fields (the current WHO method) or by examination of every fifth field moving away from the top left corner?

There was a long debate on the need for WHO and ECAMM SOPs to be harmonized in this regard. In principle, since the parasites in a thick film are not homogenously distributed, examining every fifth field will allow scanning of a larger area, which may be more representative than examining by contiguous fields.

There was agreement that the procedure followed in the ECAMM workshops for slide examination should be aligned with the WHO SOPs for validation of malaria slide banks, to minimize differences in results due to reading methods. The WHO SOP for malaria slide banks instructs readers not to skip fields, and states that each validator (i.e. an experienced Level 1 microscopist) should read each slide for 10 minutes. From WHO experience, since validators were assessing using the WHO method they knew and had already practised, they were de facto examining the thick film by contiguous fields, following the WHO SOPs.

Given the lack of data on the impact of examining the slides following either method, to resolve the current differences in the two methods, it was recommended that a study be undertaken to compare the difference in results between reading contiguous fields or every fifth field of thick film preparations. The results of this study should guide the changes required to the current WHO SOPs.

9.2 Parasite detection

B. Should the presence of malaria parasites be based on examination of 100 fields of the thick film at 100× oil immersion or on examination of 200 fields?

The lowest malaria parasite density associated with fever (i.e. the pyrogenic threshold) varies with transmission intensity and according to age, level of immunity, parasite species and even strains, as shown in analyses of malariotherapy studies *(9-12)*. The pyrogenic threshold of *P. vivax* has been estimated at 181 parasites/mm^3 (95% confidence interval [CI]: 45–734 parasites/mm^3) and is lower than that of *P. falciparum* (1460 per mm^3, 95% CI: 327–6516/mm^3). Assuming random, uniform distribution of parasites in the thick film, the probability of missing the presence of parasites at a density of 45/mm^3 is 0.05% if 100 fields of the thick film are examined with a standard microscope (1000× magnification, ocular lens with field number 20) *(9-13)*. This suggests that malaria infections that result in febrile illness should be detectable in almost all cases by examining 100 fields on the thick film, as is currently recommended in the WHO SOP.

Microscopy data from the recent IMPROV study (Taylor et al., submitted for publication), conducted to assess the effectiveness of shorter treatment regimens for radical cure of vivax malaria, were also discussed. For this study, 200 fields were examined on a thick film at 1000× magnification before declaring a slide negative. Further, if parasites were first detected after examining 40 high-power fields (HPFs), the exact number of fields examined to detect a parasite was noted. Of 1554 slides detected as positive in this study, there were only two (0.13%) – collected within 2 days of antimalarial treatment – in which parasites were detected after the examination of 100 HPFs on the thick film.

Based on these calculated probabilities and the IMPROV study microscopy data, it was concluded that, for the detection of malaria in patients with symptomatic infections, the examination of 100 fields of thick film is probably adequate. For research, however, extending the minimum requirement to 200 fields may be preferable because this would lower the limit of detection to about 5–15 parasites/mm^3 and could thus allow infections to be detected earlier during follow-up of patients. It was agreed that the current text in the WHO malaria microscopy SOPs is correct because it states, “A minimum of 100 high-power fields must be examined before a thick film can be declared as having ‘no malaria parasites seen’. If possible, the whole thick film should be scanned.” *(14)*.

9.3 Parasite counting

C. Should the parasite count be based on all parasites (asexual + sexual forms) or only on the asexual forms?

There was general agreement to keep the current recommendation as presented in the WHO malaria microscopy SOPs; that is, with only parasites in asexual form. The current text reads, "If malaria parasites are present count asexual forms (in either single or mixed species infections) without sexual (gametocyte) forms, which are not counted but just reported. In mixed infections, all asexual parasites are counted together and the presence of multiple species is reported." *(15)*.

D. Should the parasite counting start in a random field of the thick film in top left corner, or in the field where parasites and leukocytes are seen?

In the ECAMM workshops, participants already know that the slides for parasite counting are positive and, since the time for examination is limited (10 minutes per slide), it is appropriate to start counting in a random field of the thick film in top left corner. However, the pros and cons of both methods were considered for real situations where the results of the slide are not already known.

There was agreement that the procedure followed in the ECAMM workshops for slide examination should be aligned with the WHO SOPs for validation of malaria slide banks, to minimize differences in results due to reading methods. The WHO SOP for malaria slide banks does not specify when to start counting; it only states that each validator (an experienced Level 1 microscopist) should read each slide for 10 minutes. From WHO experience, since validators were assessing using the WHO method they knew and had practised already, they were de facto counting from the field where the parasites and leukocytes are first seen together in one field, following the WHO training manual SOPs.

In principle, if there is a moderate to high density of parasites on a slide, the field where counting starts will not affect the calculated parasite density. At lower parasite densities, there could be a bias if counting starts only after the first parasite is seen, but the examination time could increase if the microscopist is required to go back to the top left corner to start counting both parasites and leukocytes.

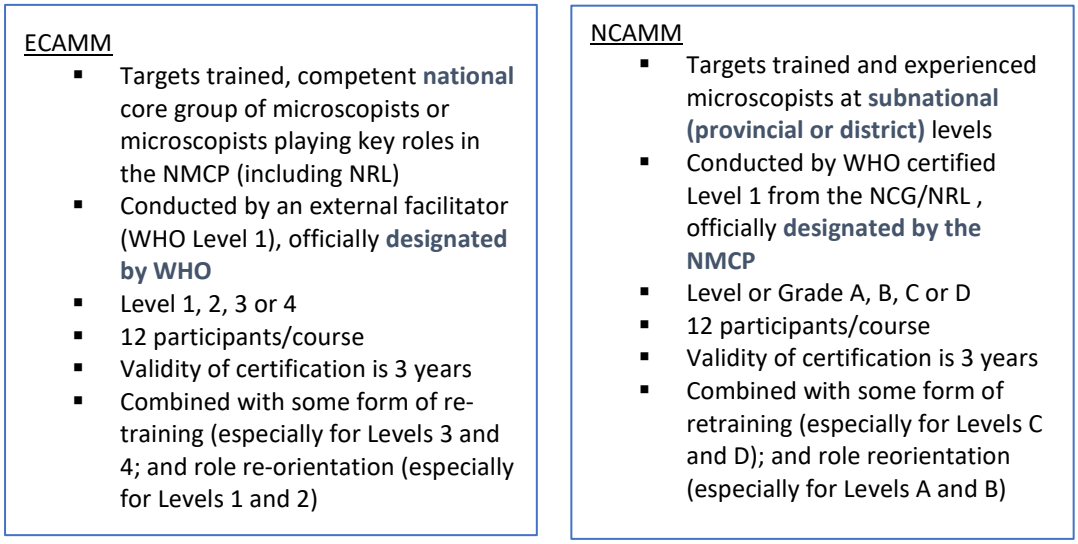
Given the lack of supportive data, it was agreed to make a minimal change to the WHO malaria microscopy SOP, to remove the requirement for the simultaneous presence of both white blood cells and parasites. The suggested change was, "Starting at the top most left part of the film, look for a field with ~~a good number of white cells and~~ parasites ~~are observed together~~ and start counting" *(15)*.

10 National competence assessment of malaria microscopists

The national competence assessment of malaria microscopists (NCAMM) programme ensures that microscopists working at subnational levels are competent to perform microscopy services, to ensure accurate results and better clinical management, and so that their performance can contribute to the achievement of malaria elimination. The NCAMM also enables the identification of the most competent microscopists, who can then be involved in QA activities, training and assessment of microscopists, slide validation and supervision; also, recognizing the competence of the best microscopists can support career development.

The comparison between ECAMM and NCAMM is shown in Fig. 14.

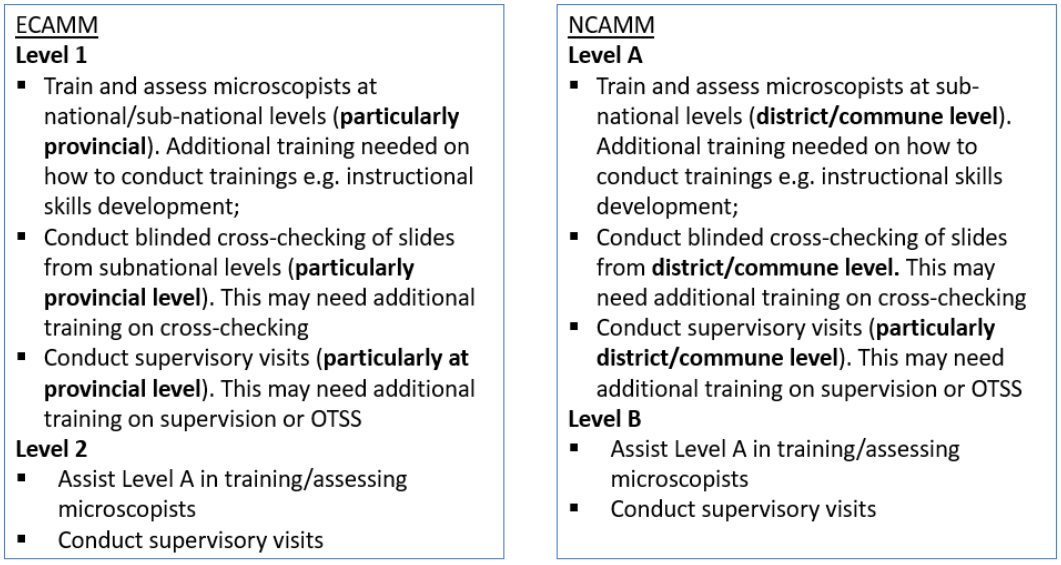
Fig. 14. Main similarities and differences between ECAMM and NCAMM



ECAMM: external competence assessment of malaria microscopists; NMCP: national malaria control programme; NRL: national reference laboratory; WHO: World Health Organization; NCG: national core group.

The potential roles for certified participants after ECAMM and NCAMM workshops are shown in Fig. 15.

Fig. 15. Potential roles for participants certified as Level 1 and 2 at ECAMM and Levels A and B at NCAMM



ECAMM: external competence assessment of malaria microscopists; OTSS: outreach training and support supervision; NCAMM: national competence assessment of malaria microscopists.

WHO recommends that NCAMM should be organized and coordinated by the NMCP, in collaboration with the national reference laboratory. It should be based on examination of 56 slides from representative national malaria slide banks, if available (if not, from WHO regional malarial slide banks at the RITM).

The target of NCAMM is to determine competency and capacity-building needs for subnational-level microscopists, and NCAMM should be tailored to the national programme context and needs. NCAMM should have less emphasis on quantification (depending on the level of care) and more emphasis on

locally prevalent species, and should include slide preparation and staining of thick and thin films (e.g. 10–20 slides).

Some findings from NCAMMs in the WHO Western Pacific Region and South-East Asia Region in relation to the preparation and staining of the 20 slides are that:

- not all subnational or even national microscopists are performing these procedures, including WHO-certified Level 1 or 2 microscopists (in some settings, nurses perform blood collection and preparation or smearing, while microscopists only read slides);
- different techniques are used in performing these procedures because not all microscopists were trained following WHO SOPs (e.g. in China and Malaysia);
- the time allotted during NCAMM may not be sufficient to perform the tasks or for the facilitator to check physically and microscopically the 20 slides prepared and stained; and
- criteria set for scoring the quality of slide preparation and staining need to be simplified and harmonized.

It was also found that, at subnational level, some laboratories are not using the parasites/µL system to quantify parasites, but instead are using the + system.

At the conclusion of a recent bi-regional training for NCAMM facilitators, convened by the WHO SEARO and WPRO, the participants made the following recommendations:

- facilitators require more training, mentoring and practice;
- countries planning to implement NCAMM must have access to reference slides;
- countries should determine the level of parasite count that is included (e.g. provincial level, or those involved in research such as therapeutic efficacy studies);
- slide preparation and staining are important and must be included in all microscopy trainings; for NCAMM, NMCPs can decide what to include or not to include, and how many slides should be prepared (e.g. in Cambodia, only 10 slides are prepared);
- some of the lectures may be omitted (e.g. QA in malaria microscopy or current and future malaria diagnostic tools); and
- reporting should be brief and concise; it is not necessary to follow the ECAMM format.

Key findings on NCAMM

- NCAMM evaluates the competence of malaria microscopists working at subnational levels within a country; it therefore targets different laboratory technicians than those targeted by ECAMM, and has different objectives.
- A set of recommendations on how to improve NCAMM were elaborated at a recent bi-regional training for NCAMM facilitators convened by SEARO and WPRO.
- There are differences in implementing ECAMM and NCAMM in different regions; for example, for PAHO, because many countries have a low malaria burden and several are moving towards elimination, ECAMM is the only possible approach to share positive slides and assess participants more thoroughly on all microscopy competencies.
- The need for support for RT and NCAMM depends on the country and situation, and it is still unclear at the moment how much support should be provided to countries to develop NCAMM programmes or to implement RT activities.

11 Process of malaria slide bank validation

11.1 Background

Malaria slide banks made of well-characterized malaria positive and negative blood films are used in training courses, proficiency testing and assessment of competency of microscopists or laboratory technicians as part of QA activities related to malaria microscopy. Thus, validation of blood samples in terms of parasite species and density, through microscopy and PCR, is a critical step in setting up a reference set of slides or a malaria slide bank.

In 2015 and 2016, five laboratories from Africa asked WHO to validate, via microscopy, blood samples collected for their national malaria slide banks. The RITM – a WHO collaborating centre for malaria diagnosis that also maintains the WHO malaria slide bank – was then contracted to perform the validation. Blood samples from the laboratories were sent to RITM and were validated following SOPs previously developed by WHO and RITM.

11.2 Procedure for validation

Microscopy validation of blood samples for national malaria slide banks requires 12 readings of slides collected from one patient sample; these readings are used to calculate the mean density with precision around ±5% *(*Gatton 2009, unpublished report). The slides are blindly read by six Level 1 microscopists with experience in slide validation; these six people read the same two slides each, to make 12 readings for each case. Final composite diagnosis for each case is determined as the diagnosis, with at least 70% agreement among all validators and with PCR. For parasite counts, the median parasite count is taken as the reference count for cases with no statistical differences between the two blind readings by the same validators (i.e. intra-reader variability) and between different validators (i.e. inter-reader variability). Slides that do not satisfy the above requirements for composite diagnosis or have statistically significant differences in the counts are clearly marked. These slides should then be avoided for use in proficiency testing and competence assessments, because they might cause confusion and disagreements among the participants.

11.3 Results of the malaria slide validation

Laboratory A sent two copies each of 38 blood samples for microscopy validation, of which 28 were *P. falciparum* (74%), three *P. ovale* (8%), three (8%) no malaria parasites seen (NMPS), two (5%) *P. malariae* and two (5%) mixed infections (*Po*+*Pm* and *Po*+*Pf*). Of the 38 blood samples, 35 (92%) had at least a 70% agreement between the 12 readings. Validators observed that a number of the samples had poor quality of films: 34% had bubbles, 18% were unreadable or blurry, and 13% had dust and dirt.

Bubbles usually form during the mounting of slides with coverslips, but regular practice using recommended SOPs can prevent bubble formation. Dust and dirt appear if the glass slides used are not thoroughly cleaned; alternatively, dust and dirt may be captured during drying of slides. Uncleaned slides can also cause poor blood films if traces of grease are present. In terms of stain quality, 13% of the slides had crystals and 8% were either understained or overstained.

Laboratory B sent two copies each of 36 blood samples for microscopy validation, of which 30 (83%) were *P. falciparum*, three (8%) NMPS, two (6%) *P. malariae* and one (3%) *P. ovale*. All blood samples had at least 70% agreement between readings. However, validators observed that some slides had auto-fixed thick films (19%), with dirt and dust (8%), or with a crack (6%). Auto-fixation of thick films may occur through contact with methanol during fixation of thin films or during drying when the temperature is not optimal (i.e. high temperature). Slides should be handled properly and carefully during preparation and shipping to prevent cracks or breakage. In terms of quality of stain, 69% of the blood samples were acidic (i.e. pinkish in colour), 25% had crystals or artefacts, and 17% were understained or were faded. The pH of buffered water should be checked and corrected to pH 7.2

before it is used, to prevent slides from being pinkish (acidic) or too dark (basic). Of the 36 samples, 13 (36%) also had lysed red blood cells (RBCs); that is, RBCs that were not completely dehaemoglobinized during Giemsa staining. Giemsa stain should also be quality checked before use to determine the optimal time for staining.

Laboratory C sent the highest number of blood samples (80, with two copies of each) for microscopy validation, of which 27 (34%) were mixed infections, 21 (26%) *P. malariae*, 17 (21%) *P. falciparum* and 15 (19%) *P. ovale*. However, only 19 blood samples (24%) had at least 70% agreement between readings. Validators observed that of the 80 samples, nine (11%) were poorly prepared. This may have been caused by greasy slides that were not properly cleaned before use, poor staining or mounting of coverslips, or unexperienced microscopists performing the procedures. Practice following recommended SOPs is required to prepare high-quality films. In terms of stain quality, 14% were understained or faded, 14% were acidic (pinkish in colour), and 7.5% had crystals or artefacts. Quality control of Giemsa stain and buffered water before use are required for proper staining of a blood film. Also, different codes were used in labelling the blood samples sent for validation.

Laboratory D sent the smallest number of blood samples (29 with two copies each), of which 15 (52%) were *P. vivax*, eight (28%) *P. falciparum* and six (21%) mixed infections of *P. vivax* + *P. falciparum*. Of the 29 samples, 27 (93%) had at least 70% agreement between readings. Observations made by the validators included films with dirt or dust (24%), blood samples understained or faded (31%), and with crystals and artefacts (10%). During removal of Giemsa stain, laboratory staff should ensure that iridescent green scum does not touch the blood film to avoid crystals or artefacts adhering to the slide.

Laboratory E sent two copies of 39 blood samples, of which 27 (69%) were *P. falciparum*, seven (18%) were NMPS, three (8%) were mixed infections and two (5%) were *P. vivax*. Of the 39 samples, 36 (92%) had at least 70% agreement between readings, but almost half (49%) had dust or dirt, and 26% were not fit for reading. In terms of the quality of staining, 31% of the samples had crystals or artefacts and 21% were poorly stained (understained or overstained). Also, different codes were used in labelling the blood samples sent for validation.

12 Conclusions

Objective 1. To review the results of ECAMM workshops conducted since 2009 by multiple institutions, and to evaluate the need for updating the current WHO criteria for certification of competence in relation to detection, species determination and parasite density calculation, including potential impact on certification levels if new criteria are recommended for adoption.

a. Criteria for parasite counting should remain at a count of ±25% within the true count instead of increasing to ±50%, based on the analysis of the results of ECAMM workshops conducted from 2009 to 2018, to avoid a major change in levels of competencies and to avoid losing (with the current assessment method) the capacity to distinguish four different levels of competence.

b. Scoring criteria for mixed infections will be changed so that microscopists can be rewarded for identifying a second infection, even if they identify the wrong species. A new scoring system for mixed infections will be trialled until December 2019 and then reassessed. The analysis of the results of ECAMM workshops conducted from 2009 to 2018 showed that this change in scoring criteria will not result in any major change in levels of competence of participants.

c. It was suggested that the assessment for ECAMM be started on Day 3, after participants had been given more teaching and practice on species identification and parasite density calculation.

Objective 2. To review experiences of the combination of ECAMM workshops with different forms of microscopy RT, and to provide guidance on the ideal mix of training plus assessment, as well as recommendations on revised curricula of the pre-ECAMM RT and the ECAMM workshops.

a. There was an agreement that RT was an important and essential process, and that it should continue to be conducted to increase skills and knowledge of participants before ECAMM, in addition to routine RT. Analysis of the impact of pre-ECAMM RT on levels of ECAMM showed significant findings in workshops conducted in Africa *(5)*, but no conclusive impact in the analysis of all ECAMM databases.

b. The content and slide set of RTs should be better harmonized between regions, and all human species of malaria should be included in the training.

c. Only slides that are validated for ECAMM following the WHO SOP for malaria slide banks should be used, as is done currently. There is a need to expand the current WHO slide bank maintained at RITM with additional slides for *P. ovale, P. malariae* and mixed infections.

Objective 3. To review the variants of malaria microscopy SOPs for slide examination in relation to detection, species identification and parasite density calculation adopted by multiple agencies, taking into consideration the SOPs developed by WHO; the aim being to foster harmonization around common SOPs.

a. A study should be conducted to evaluate results with examination of thick films by contiguous fields or every fifth field, and the results should inform the need for updating the current malaria microscopy SOPs. A small working group of meeting participants will work on the study protocol for this.

b. Examination of 100 HPF of thick film is sufficient for detecting malaria parasites in the ECAMM workshop and for examination of patients with clinical malaria. The examination of 200 fields is more useful and relevant for research on low-density parasitaemia.

c. Counting of parasites should be based on asexual parasites only.

d. Counting of parasites should start at the first parasite seen. Although this biases the parasite count towards a higher density, it is a more practical approach, especially in settings where most slides are negative, because the whole slide does not have to be scanned first to assess whether any parasites are present.

Objective 4. To review e-learning platforms recently developed for malaria microscopy and their potential application for RT and self-assessment, in view of the potential wider dissemination and adoption of these learning tools.

a. e-learning tools are a useful addition to malaria microscopy training and as an additional way for candidates to prepare for ECAMM, but should not be used to replace hands-on learning.

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Annex 1: List of participants

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Annex 2: Analysis of ECAMM data 2009-2018

Dr Michelle Gatton, Queensland University of Technology, December 2018

Data management

Data were supplied as a series of Excel spreadsheets on 6th December (participant data) and 10th December (validated slide data), with a revision to the participant data supplied on 18th December 2018. Data originated from several different sources including the ECAMM database, T 015 forms and Annex B, I, J and K. Preliminary cleaning of the data was performed and several adjustments made. Details are contained in Appendix 1.

Only ECAMM data provided to Dr Glenda Gonzales (WHO Regional Office for Western Pacific) by June 2018 were included in the data set. Thus workshops conducted after this date are not included, nor workshops conducted before this date whose data were not submitted in time.

The number of ECAMM workshops attended by each participant was determined by identifying duplicate participant names (first and last name), and where data were available, having the same sex and expected change in age between workshops. Categories for participant age and years of service were created and raw data on participant designation were reviewed and seven summary groups created (Appendix 2).

A new variable indicating whether the participant had undertaken WHO refresher training prior to the ECAMM workshop was created from the variable 'last training attended'. Any reference to "refresher training" or "WHO refresher" was considered indicative of refresher training (Appendix 2).

Where individual slide data were available the scores for parasite detection, species identification and parasite count within 25% of true count were calculated. These calculated values were used to investigate the impact of nominated changes to the ECAMM competence and certificate levels.

Results

Summary of participants and ECAMM workshops

Data for 1485 participants who attended 125 ECAMM workshops between 1 January 2009 and 30 June 2018 was available for analysis. The mean age of participants was 38.8 years (n=1115, sd 8.9 years) and the majority (862/1485, 58.1%) were male (Figure 1). Participants were from 59 countries, with Papua New Guinea providing the largest number (191/1485, 12.9%), followed by Australia (91/1485, 6.1%) and Uganda (85/1485, 5.7%) (Figure 2, Appendix 3).

1226 individuals participated in ECAMM workshops with 1075 (87.7%) attending one workshop, 111 (9.1%) attending 2 workshops and 40 (3.3%) attending 3 or 4 ECAMM workshops between 2009 and 2018.

Figure 1. Temporal distribution of ECAMM participants between 2009 and 30 June 2018

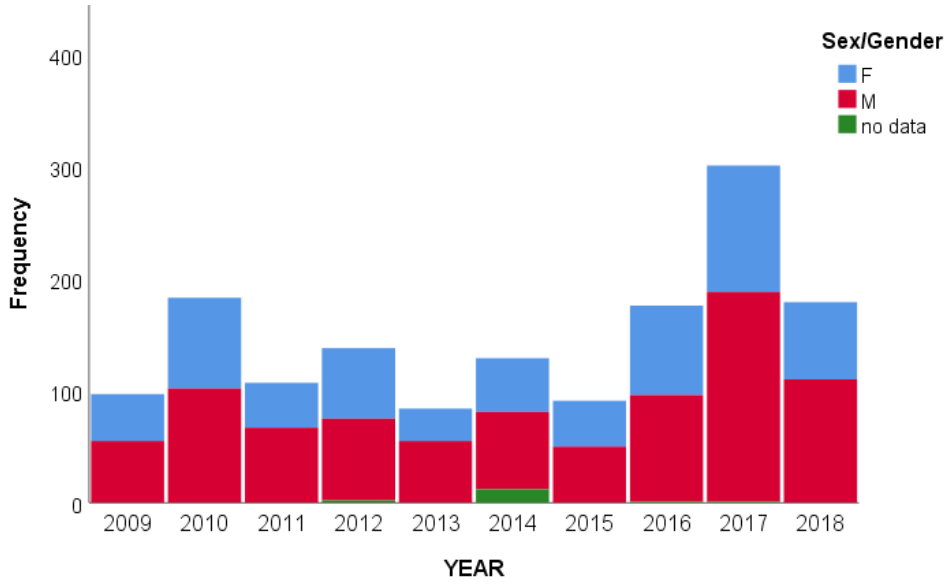
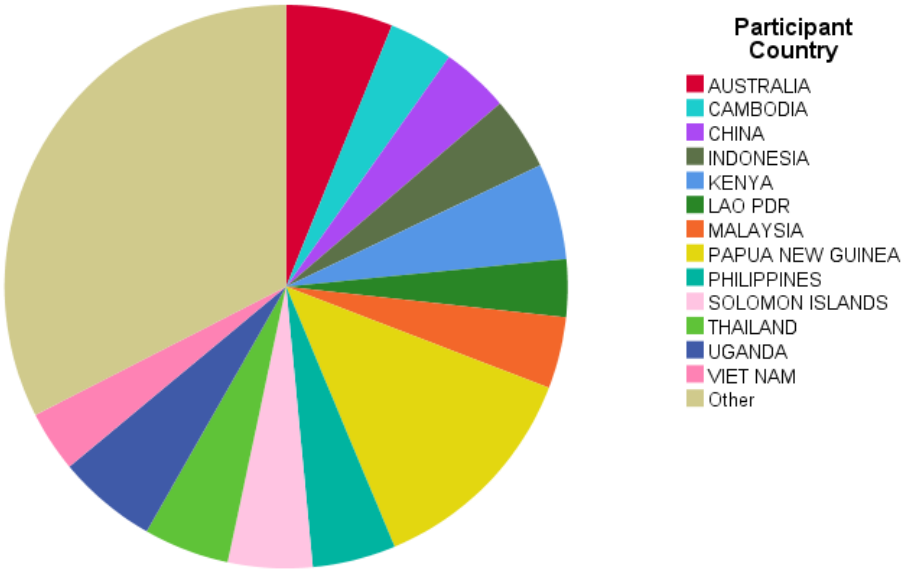
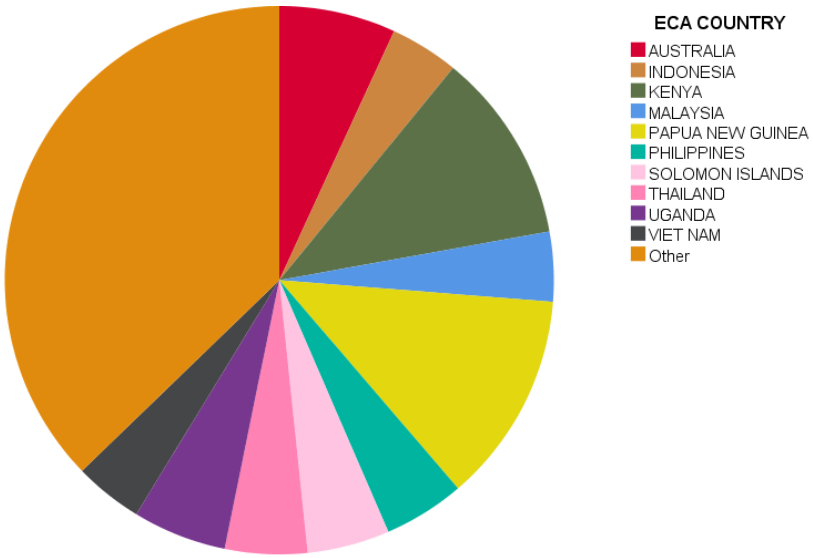


Figure 2. Distribution of participants attending ECAMM workshops according to country of the participant. Only countries with >3% of total ECAMM participants are shown individually. All countries are listed in Appendix 3



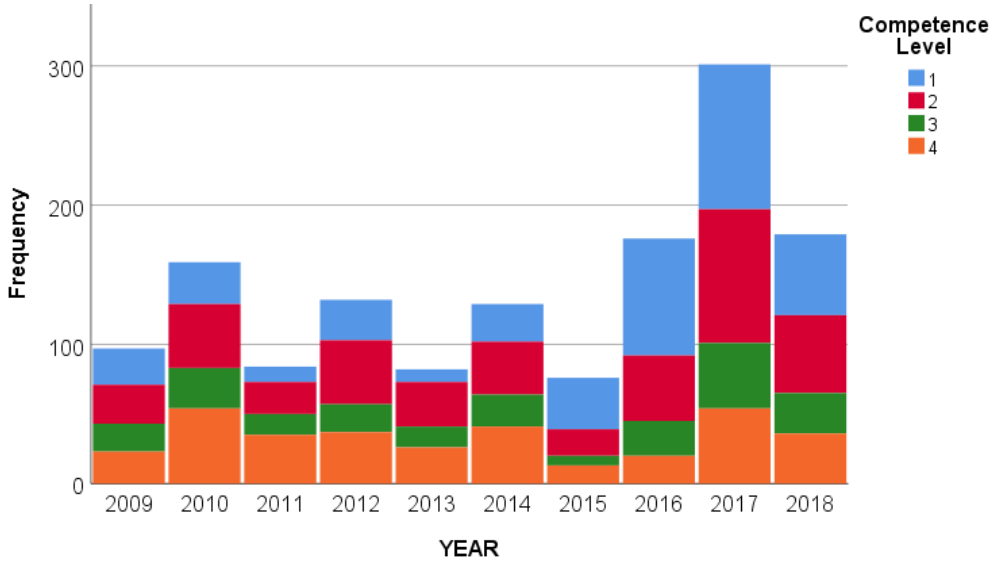
ECAMM workshops have been conducted in 34 countries with workshops in Papua New Guinea (185, 12.5%) and Kenya (167, 11.2%) assessing the most participants during the study period (Figure 3).

Figure 3. Distribution of participants attending ECAMM workshops according to country in which ECAMM was conducted. Only countries with >4% of total ECAMM participants are shown individually



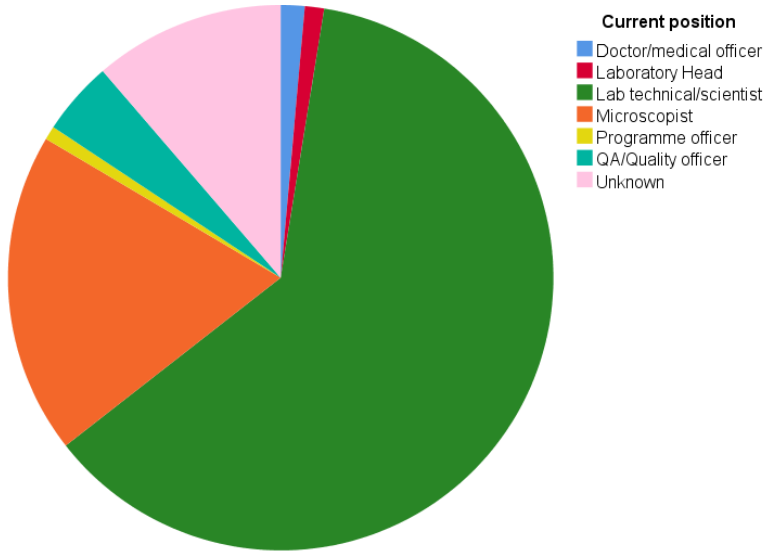
Competency level was available for 1415 participants with 412 (29.1%), 433 (30.6%), 231 (16.3%) and 339 (24.0%) achieving Level 1, Level 2, Level 3 and Level 4, respectively (Figure 4). There was a significant association between ECAMM Level and country in which the ECAMM was conducted (Pearson's Chi-square, p<0.001), with ECAMM conducted in the Philippines having the highest proportion of participants achieving Level 1 (80.3%), followed by Indonesia (48.3%) and Malaysia (42.6%). The lowest proportions of participants achieving Level 1 occurred in ECAMM conducted in Solomon Islands (8.6%), Papua New Guinea (8.6%) and Uganda (10.3%).

Figure 4. Distribution of ECAMM competence levels between 2009 and 2018



The majority (919/1485, 61.9%) of participants indicated their current position as a laboratory technician or scientist, with microscopist being the second largest group with 283 (19.1%) of the participants (Figure 5).

Figure 5. Self-reported participant designation at time of ECAMM workshop



Participant predictors of ECAMM Competence Level

Data for the first ECAMM workshop that each participant attended was analysed to assess the association between participant demographic and work factors, and level of competence achieved.

There was an association between sex/gender and competence level (Chi-square test, p=0.006), with females being more likely to achieve Level 1 than their male counterparts (30.8% compared to 23.0%) and less likely to achieve Level 4 (22.7% compared to 28.9%).

There was some evidence of an association between age and competence level with a higher proportion of participants aged 40 years or less obtaining Levels 1 or 2 compared to those aged over 40 years. However this association was not statistically significant (Chi-square test, p=0.063). There was also no statistical association between length of service and competence level (Chi-square, p=0.254), however there was a trend for participants with less than 2 years of service to have a lower proportion achieving Level 1 competency (Figure 6).

Figure 6. Relationship between years of service and ECAMM Competency Level

There was an association between current position and competency level (Chi-square test, p=0.001), with participants employed as quality assurance or quality officers having the highest proportion (21/60, 35.0%) achieving Level 1 competence. Participants identifying themselves as microscopists had the lowest proportion of Level 1 competence (44/225, 19.6%) (Figure 7).

Figure 7. Relationship between self-reported designation and competence level

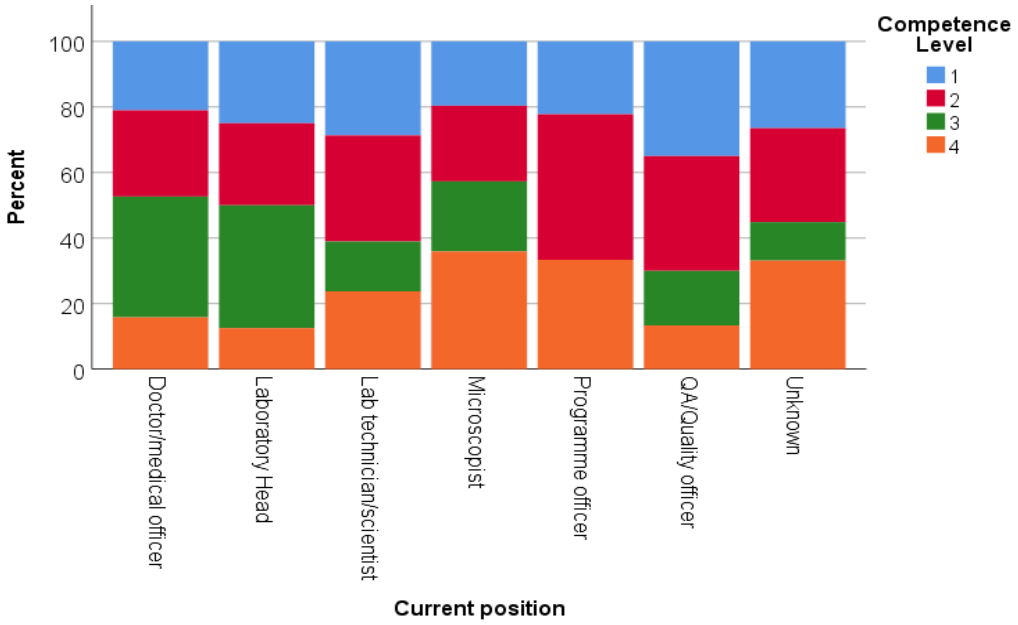


Table 1. Summary of bivariate associations between participant variables and ECAMM competence level

VARIABLE	SIGNIFICANTLY ASSOCIATED WITH ECAMM COMPETENCE LEVEL (AT P<0.05)
Sex	Yes
Age	No
Length of service (in current position)	No
Current position	Yes

A multivariable binary logistic regression model was used to investigate factors associated with achieving Level 1 competence. Sex/gender and age group were both significant predictors ($p<0.03$), although the explanatory power of the model was low (Nagelkerke R^2 0.03, n=947). Current position and years of service were not significant after adjusting for sex and age of participant. The highest odds of achieving Level 1 competence were for females aged 26-40 years (Table 2).

Table 2. Odds ratios for achieving Level 1 competence for significant variables included in binary logistic regression model. CI: confidence level; ns: not significant

VARIABLE	GROUP	ODDS RATIO (95% CI)	P-VALUE
Sex/gender	Male	Ref	
	Female	1.43 (1.08 – 1.89)	0.014
Age	<=25 years	Ref	
	26-40 years	2.10 (0.99 – 4.47)	0.053
	41-55 years	1.42 (0.65 – 3.08)	0.379 (ns)
	>55 years	1.36 (0.46 – 4.02)	0.576 (ns)

Influence of WHO Refresher training in the week prior to ECAMM

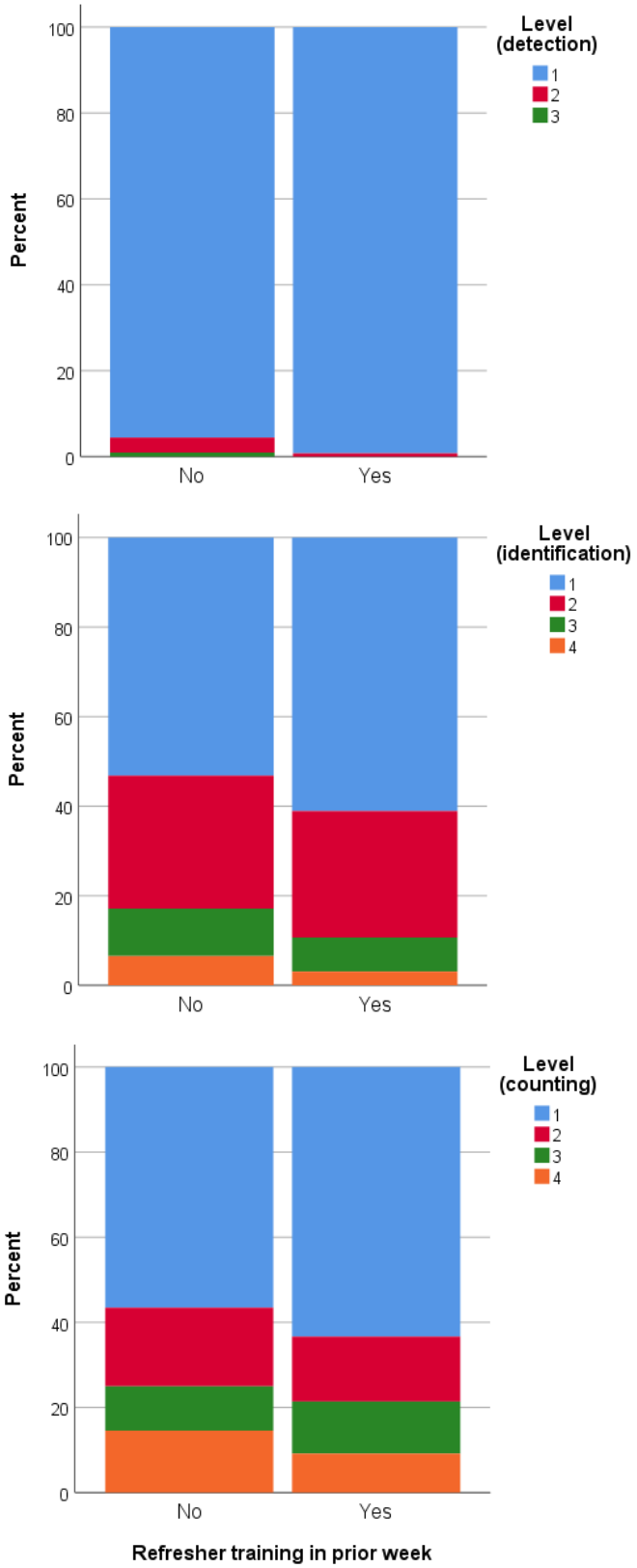
Since 2016, 20.0% (131/656) of participants attended ECAMM workshops which were immediately preceded by refresher training. Although there was a trend for higher ECAMM Competence Levels for those who had refresher training immediately prior to the ECAMM Workshop, this trend did not reach statistical significance (Linear-by-Linear Association, p=0.092) (Table 3).

Table 3. ECAMM Competence levels for 656 participants completing workshops (2016-18), categorised according to whether the participant undertook Refresher Training in the week prior to the workshop

ECAMM LEVEL	REFRESHER TRAINING		TOTAL
	No	Yes	
1	186 (35%)	57 (44%)	243
2	165 (31%)	36 (28%)	201
3	80 (15%)	22 (17%)	102
4	94 (18%)	16 (12%)	110
Total	525 (100%)	217 (100%)	656

The individual components (parasite detection, identification and counting) of ECAMM were also assessed for an association with refresher training. There was a linear association between having done refresher training and ECAMM Level for parasite detection (Linear-by-Linear Association, p=0.050), and ECAMM Level for species identification (Linear-by-Linear Association, p=0.038), but no association with ECAMM Level for counting (Linear-by-Linear Association, p=0.140) (Figure 8).

Figure 8. ECAMM Level for parasite detection (top), species identification (middle) and counting (bottom) according to whether participants had refresher training in the week prior to ECAMM, for participants attending ECAMM Workshops 2016-2018.



Comparison of pre-ECAMM and ECAMM results

Significant improvements in parasite detection, species identification and counting were seen between the pre-ECAMM slides and the ECAMM results (p<0.001). On average, parasite detection increased by 3.1% (95% CI 2.3 – 3.9, paired t-test, n=366), species identification increased by 16.1% (95% CI 12.4 – 14.1%, paired t-test, n=1362) and counting within 25% of the true value increased by 12.7% (95% CI 11.4 – 14.1%, paired t-test, n=1350).

The pre-ECAMM and ECAMM results were significantly correlated for all three outcome measures; parasite detection (r=0.573, p<0.001 n=366), species identification (r=0.672, p<0.001, n=1362) and parasite count (r=0.329, p<0.001, n=1350) (Figures 9-11).

Figure 9. Relationship between Pre-ECAMM and ECAMM parasite detection score

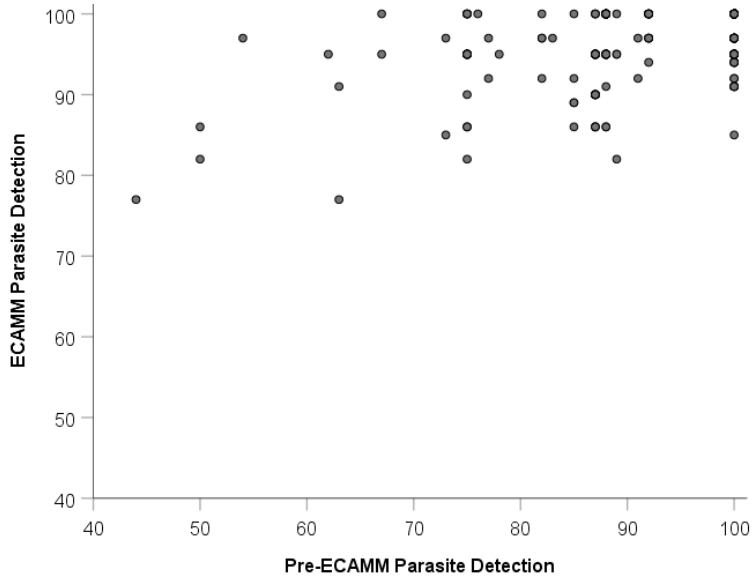


Figure 10. Relationship between Pre-ECAMM and ECAMM species identification scores

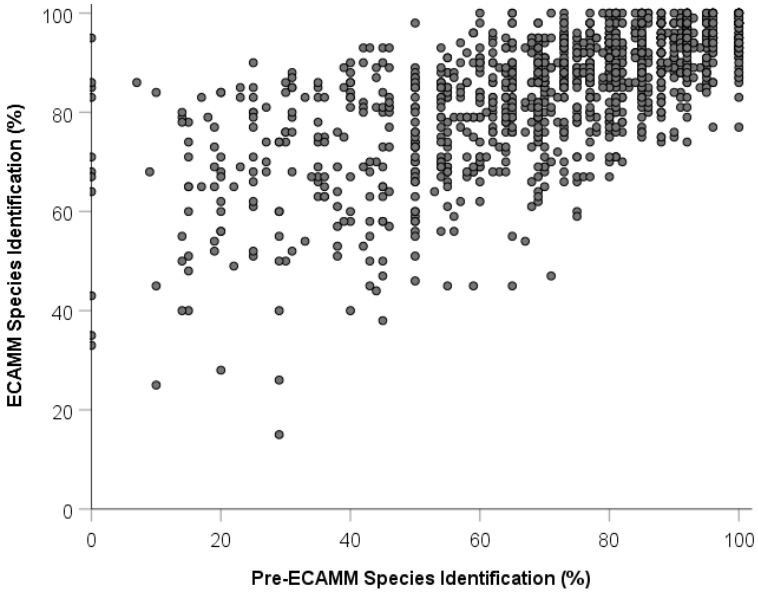
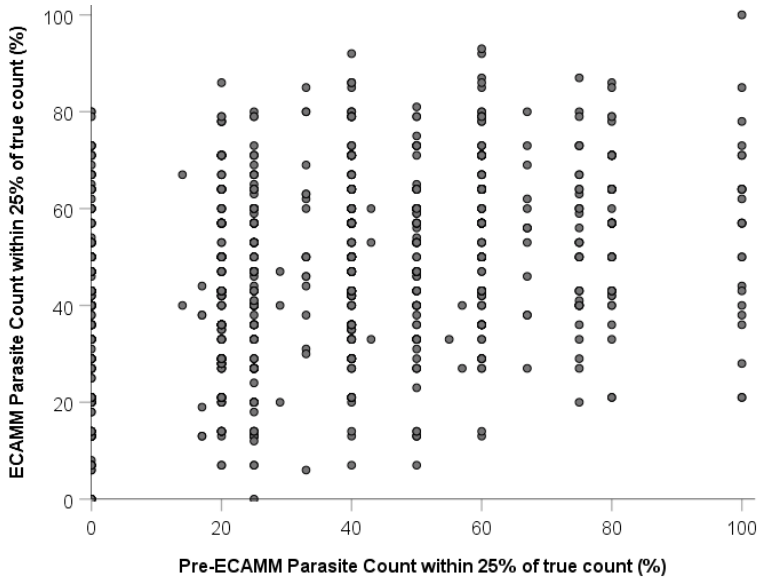


Figure 11. Relationship between Pre-ECAMM and ECAMM parasite count within 25% of true count



Predicting ECAMM Competence Level using pre-ECAMM results

ROC analysis was used to determine thresholds for pre-ECAMM parasite detection, species identification and parasite count for each ECAMM competence level (Table 4). Each threshold represents the value which maximises Youden's Index.

Table 4. Thresholds for pre-ECAMM results that best differentiate ECAMM Competence Level

ECAMM LEVEL	THRESHOLDS FOR PRE-ECAMM RESULTS		
	Parasite detection	Species identification	Counting
1	96.0	83.5	36.5
2	86.0	60.5	18.5
3	65.0	45.5	15.5

367 participants had a predicted level for all three outcome measures, with 151 (41.1%) having the same predicted level for each outcome measure. The number of participants with predictions based on species identification and parasite count only was considerably higher (1372), reflecting the lack of pre-ECAMM parasite detection data for early ECAMM workshops. Within these 1372 participants, 598 (43.6%) had the same predicted level based on species identification and parasite count.

The ECAMM level was correctly predicted for 180/367 (49.0%) participants using pre-ECAMM parasite detection results and the thresholds reported in Table 4. The highest accuracy of prediction was for Level 1, with 249 participants predicted to achieve Level 1, and 135 (54.2%) actually obtained this level.

Using pre-ECAMM species identification data alone and the calculated thresholds correctly predicted the ECAMM level for 632/1350 (46.8%) of participants. The highest accuracy was for Level 4 where 175 participants were predicted to obtain Level 4, with 115 (65.7%) actually obtaining this level. The second best accuracy was obtained for Level 1 where 497 participants were predicted to obtain this level, and 273 (54.9%) actually did.

Using pre-ECAMM count data alone and the thresholds produced the lowest prediction accuracy for ECAMM level with 538/1350 (39.9%) of participants correctly classified. The highest accuracy was for Level 4 where 267 participants were predicted to obtain Level 4, and 124 (46.4%) actually did. Only six participants were predicted to achieve Level 3 due to the narrow range of pre-CAMM count results assigned to this level; 15.5 – 18.4% (Table 4).

The accuracy of the prediction of ECAMM level did not improve when several pre-ECAMM outcome measures were considered simultaneously (e.g. minimum or maximum predicted level based on species identification and parasite count).

Determinants of ECAMM Levels 2, 3 and 4

Level 2 competence

414 participants who were awarded Level 2 had data for species identification and counting. Almost one quarter (100/414, 24.2%) had Level 2 competence for both species identification and counting, while half (209/414, 50.5%) met the competence criteria for Level 1 in counting (Table 5).

A subset of 220 participants had data for parasite detection, species identification and counting. The large majority (217/220, 98.6%) of participants who achieved Level 2 met the criteria for Level 1 parasite detection (Table 6).

For participants achieving Level 2 competence it appears that species identification was the major determinant for achieving this level.

Table 5. Level achieved for species identification and counting for participants who achieved ECAMM Level 2

ECAMM LEVEL (SPECIES IDENTIFICATION)	ECAMM LEVEL (COUNTING)		TOTAL
	1	2	
1	3	105	108
2	206	100	306
Total	209	205	414

Table 6. Level achieved for parasite detection, species identification and counting for participants who achieved ECAMM Level 2

ECAMM LEVEL (DETECTION)	ECAMM LEVEL (SPECIES IDENTIFICATION)	ECAMM LEVEL (COUNTING)		TOTAL
		1	2	
1	1	3	60	63
	2	110	44	154
	Total	113	104	217
2	1	0	0	0
	2	2	1	3
	Total	2	1	3
Total	1	3	60	63
	2	112	45	157
	Total	115	105	220

Level 3 competence

217 participants who achieved Level 3 had data for both species identification and counting. Almost half (99/217, 45.6%) of participants met a higher competence level for counting, while 94/217 (43.3%) met a higher competence level for species identification (Table 7). Almost half (101/217, 46.5%) met the criteria for Level 1 in either species identification or counting.

Table 7. Level achieved for species identification and counting for participants who achieved ECAMM Level 3

ECAMM LEVEL (SPECIES IDENTIFICATION)	ECAMM LEVEL (COUNTING)				TOTAL
	1	2	3	4	
1	1	0	50	0	51
2	0	0	42	1	43
3	50	48	25	0	123
Total	51	48	117	1	217

Only 111 participants who achieved Level 3 had data for parasite detection, species identification and counting. The large majority of these participants (106/111, 95.5%) met the criteria for Level 1 parasite detection.

For participants achieving Level 3 it appears that both species identification and counting were the major determinants for achieving this level.

Level 4 competence

314 participants who achieved Level 4 had data for both species identification and counting. Almost half (156/314, 49.7%) of participants met the criteria for a higher level for species identification, while 76/314 (24.2%) met a higher criteria for counting (Table 8).

146 (46.5%) of the Level 4 participants had data for parasite detection, species identification and counting. Only one participant achieved Level 4 for parasite detection, while 5 (3.4%), 23 (15.7%) and 117 (80.1%) met the criteria for Level 3, Level 2 and Level 1 parasite detection, respectively.

For Level 4 participants it appears that parasite counting is the major determinant for the level achieved, followed by species identification.

Table 8. Level achieved for species identification and counting for participants who achieved ECAMM Level 4

ECAMM LEVEL (SPECIES IDENTIFICATION)	ECAMM LEVEL (COUNTING)				TOTAL
	1	2	3	4	
1	0	0	0	38	38
2	0	0	0	70	70
3	0	0	0	48	48
4	19	33	24	82	158
Total	19	33	24	238	314

Relationship between quantification accuracy and parasite density

The accuracy of parasite counting was highest for slides with true counts between 501 and 2,000 parasites/µL (Table 8). Within this parasite density range almost 50% of counted slides were within

25% of the true value, with a mean percentage difference of 23.3%. Slides with true densities below 500 parasites/µL produced the lowest counting accuracy (Table 9).

Table 9. Details of parasite counting scores according to true slide density

TRUE SLIDE DENSITY (PARASITES/µL)	NO. SLIDES WITH PARASITE COUNTS WITHIN 25% OF TRUE VALUE / NO. SLIDES (%)	MEAN (ABSOLUTE) PERCENTAGE DIFFERENCE BETWEEN COUNT & TRUE COUNT	MEDIAN (ABSOLUTE) PERCENTAGE DIFFERENCE BETWEEN COUNT & TRUE COUNT
200 - 500	2305/6650 (34.7%)	48.6	27.3
501 - 2,000	5750/11540 (49.8%)	23.3	15.0
40,000 - 100,000	983/2478 (39.7%)	47.7	32.4

Change in performance during ECAMM

All ECAMM workshops conducted since February 2016 have followed the same structure in which 19, 19 and 18 slides are examined on Days 1, 2 and 3, respectively. Data for participants in these workshops was examined to investigate whether performance outcomes changed during the course of the workshop. Only pooled data was examined due to the small number of slides examined each day by each individual.

Overall species identification and parasite counting improved across the three days (Table 10). The largest improvements in species identification occurred amongst participants who achieved ECAMM Level 4 changing from 73.0% correct species identification on Day 1 to 83.1% on Day 3. The largest improvements in parasite counting were amongst the Level 2 and 3 participants who changed their counting scores from 44.6% and 37.6% on Day 1 to 57.1% and 50.1% on Day 3, respectively. Although not a directly measured outcome, the largest overall changes were seen in the average percentage difference between parasite counts and true slide counts with a decrease of 17.4% (Table 10). Level 4 participants displayed a dramatic reduction in the percentage difference in counts from 74.1% on Day 1 to 39.6% on Day 3.

Table 10. Summary of outcome measures for parasite detection, species identification and parasite counting for each Day of the ECAMM workshop for all participants attending workshops between 2016 and 2018

		DAY 1	DAY 2	DAY 3	OVERALL	CHANGE FROM DAY 1 TO DAY 3
Parasite Detection		97.6%	95.9%	97.9%	97.1%	0.3%
Species identification	Total	85.3%	89.0%	91.6%	88.6%	6.3%
	Level 1	93.6%	95.9%	96.2%	95.1%	2.6%
	Level 2	84.5%	88.8%	92.4%	88.5%	7.9%
	Level 3	80.4%	84.8%	88.0%	84.3%	7.6%
	Level 4	73.0%	78.1%	83.1%	78.0%	10.1%
Parasite count within 25% of true value	Total	45.3%	50.2%	55.4%	50.2%	10.1%
	Level 1	57.6%	62.0%	66.1%	61.8%	8.5%
	Level 2	44.6%	51.7%	57.1%	51.0%	12.5%
	Level 3	37.6%	40.3%	50.1%	42.7%	12.5%
	Level 4	26.0%	30.4%	33.3%	29.8%	7.3%
Average % difference between count and true count	Total	36.0	28.7	18.6	19.1	-17.4
	Level 1	21.8	17.7	14.7	12.1	-7.1
	Level 2	29.8	23.3	16.1	15.7	-13.7
	Level 3	40.8	31.4	20.0	20.6	-20.8
	Level 4	74.1	60.5	30.6	39.6	-43.5

Relationship between ECAMM level achieved and attending multiple ECAMM workshops

Data on ECAMM level was available for 130 participants who attended two (or more) ECAMM workshops. Approximately 20% (28/130, 21.5%) achieved Level 1 at both workshops. There was a significant change in the ECAMM level obtained between the first and second workshop (McNemar-Bowker test, p<0.001), with 60/130 (46.2%) obtaining a higher ECAMM level at the second workshop, compared to 10/130 (7.7%) who had a lower ECAMM level following the second workshop (Table 11).

Table 11. Comparison of ECAMM Level achieved after first and second ECAMM workshops

ECAMM LEVEL (1ST ECAMM)	ECAMM LEVEL (2ND ECAMM)				TOTAL
	1	2	3	4	
1	28	3	1	0	32
2	19	19	4	0	42
3	6	11	6	2	25
4	5	13	6	7	31
Total	58	46	17	9	130

Considering the individual outcome measures, 61/130 (46.9%) participants achieved the same level for species identification, while 54/130 (41.5%) and 15/130 (11.5%) increased and decreased levels, respectively. Approximately one third (42/130, 32.1%) of participants obtained Level 1 for species identification at both ECAMM workshops (Table 12). On average, species identification increased 5.2% (95% CI 3.3 – 7.0%) between the first and second ECAMM (paired t-test, p<0.001), with participants achieving Level 4 in the first ECAMM having the greatest improvement (Table 13). Participants who achieved Level 1 in their first workshop did not show any significant change in species identification between the first and second workshops.

Table 12. Comparison of level achieved for species identification after first and second ECAMM workshops

LEVEL FOR SPECIES IDENTIFICATION (1ST ECAMM)	LEVEL FOR SPECIES IDENTIFICATION (2ND ECAMM)				TOTAL
	1	2	3	4	
1	42	6	2	1	51
2	21	11	5	0	37
3	13	10	4	1	28
4	2	5	3	4	14
Total	78	32	14	6	130

Table 13. Change in species identification and counting scores between first and second ECAMM workshops

ECAMM LEVEL (1ST ECAMM)	MEAN CHANGE IN SPECIES IDENTIFICATION BETWEEN 1ST AND 2ND ECAMM (95% CI)	MEAN CHANGE IN PERCENT OF SLIDES COUNTED WITHIN 25% OF TRUE VALUE BETWEEN 1ST AND 2ND ECAMM (95% CI)
1	0.1% (-2.0 – 2.2%)	-6.0% (-10.8 - -1.2%)
2	4.1% (1.6 – 6.6%)	4.8% (0.4 – 9.2%)
3	8.3% (3.9 – 12.6%)	7.5% (0.8 – 14.2%)
4	10.4% (5.8 – 14.9%)	19.2% (12.9 – 25.5%)

Forty percent (52/130) of participants obtained Level 1 for parasite counting at both ECAMM workshops, while a further 40% (52/130) increased their level of achievement for parasite counting (Table 14). The average percent of slides counted within 25% of the true value increased by 5.8% (95% CI 2.7 – 8.9%) between the first and second workshops (paired t-test, p<0.001). Participants achieving Level 4 in their first ECAMM showed the largest change in the parasite counting score with an increase of 19.2% (95% CI 12.9 – 25.5%) (Table 13). In contrast, those who achieved Level 1 in their first ECAMM showed a significant reduction in counting score of 6.0% (1.2 – 10.8%) (paired t-test, p=0.017).

Table 14. Comparison of level achieved for parasite counting after first and second ECAMM workshops

LEVEL FOR COUNTING (1ST ECAMM)	LEVEL FOR COUNTING (2ND ECAMM)				TOTAL
	1	2	3	4	
1	52	4	1	1	58
2	24	12	2	2	40
3	6	3	1	1	11
4	9	6	4	2	21
Total	91	25	8	6	130

There was no significant change in ECAMM Level for 37 participants between their second and third workshops (McNemar-Bowker test, p=0.429). A total of 10/130 (7.7%) improved their achieved competency level compared to 6/130 (4.6%) who had a reduction in level between the second and third workshops.

Impact of changes to current ECAMM scoring

Change in parasite quantification cut-off

When the quantification cut-off for correctly counting a slide is increased from ±25% to ±50% the overall accuracy of quantification increases from 44.6% (9762/21887) to 68.9% (15074/21887), with approximately the same levels of increase across parasite densities (Table 15).

Table 15. Change in parasite counting due to increase in quantification cut-off from 25% to 50%

TRUE SLIDE DENSITY (PARASITES/µL)	NO. SLIDES WITH PARASITE COUNTS WITHIN 25% OF TRUE VALUE / NO. SLIDES (%)	NO. SLIDES WITH PARASITE COUNTS WITHIN 50% OF TRUE VALUE / NO. SLIDES (%)	MEAN CHANGE IN PARASITE COUNTING SCORE (%)
200-500	2305/6650 (34.7%)	3770/6650 (56.7%)	22.0
501-2,000	5750/11540 (49.8%)	8804/11540 (76.3%)	26.5
40,000-100,000	983/2478 (39.7%)	1551/2478 (62.6%)	22.9

This change in quantification threshold results in a change in ECAMM Level for 389/1485 (26.6%) of participants, with 222/1485 (15.0%) improving one level, 134/1485 (9.0%) improving 2 levels and 33/1485 (2.2%) improving 3 levels. Participants achieving Level 3 would have the largest change with 49.5% of this group moving to a higher level (Table 16).

Table 16. Comparison of ECAMM Level achieved using 25% and 50% quantification cut-offs

ECAMM LEVEL (25% CUT-OFF FOR QUANTIFICATION)	ECAMM LEVEL (50% CUT-OFF FOR QUANTIFICATION)				TOTAL
	1	2	3	4	
1	433	0	0	0	433
2	115	317	0	0	432
3	71	45	121	0	237
4	33	63	62	224	382
Total	652	425	183	224	1484

Applying the change to the quantification cut-off only to slides with parasite counts ≤500 parasites/µL would result in 14.2% (211/1485) of participants increasing the ECAMM level achieved (Table 16). Of those participants with a changed ECAMM Level, 180/211 (85.3%) would improve one level, while 31 (14.7%) would improve two levels. Participants achieving Level 3 would have the largest change with 29.5% (70/237) of this group moving to a higher level (Table 17).

Table 17. Comparison of ECAMM Level achieved using current 25% cut-off for quantification for all slides versus 50% cut-off for slides with ≤500 parasites/µL and 25% cut-off for other slides

ECAMM LEVEL (25% CUT-OFF FOR QUANTIFICATION)	ECAMM LEVEL (50% QUANTIFICATION CUT-OFF FOR LOW DENSITY SLIDES & 25% OTHERWISE)				TOTAL
	1	2	3	4	
1	433	0	0	0	433
2	77	355	0	0	432
3	16	54	167	0	237
4	0	15	49	318	382
Total	526	424	216	318	1484

Change in scoring for mixed infections

The current scoring matrix for species identification does not acknowledge the correct detection of a species in a mixed infection when the participant indicates a mixed infection, but gets one of the species incorrect. For example, a mixed Pf/Pv infection is scored 2 if the participant correctly identifies both species, 1 if they identify either Pf or Pv and 0 if they identify either Pf or Pv mixed with a different species. The data were used to explore the impact of changing the scoring for this last situation from 0 to 1 in recognition of the correct identification of one of the species.

The change in scoring of mixed infections resulted in a changed species detection score for 330/1485 (22.2%) participants. However this only changed the overall ECAMM level achieved for 3.0% (10/330) of these participants, all of whom achieved Level 4. Thus the impact of a change to scoring of mixed infections would only impact 2.9% (10/339) of Level 4 participants.

Across all participants the species identification score increased by an average of 0.24% (95% CI 0.22 – 0.27%) (paired t-test, $p<0.001$). The largest changes in species identification score occurred for participants achieving Level 3 (mean increase 0.39, 95% CI 0.31 – 0.47) and Level 4 (mean increase 0.35, 95% CI 0.29 – 0.42).

Availability of raw data from T 015 form

Raw data from the T 015 form was available for 780/1485 (52.5%) of ECAMM participants. Raw data was available for less than 20% of participants who attended ECAMM workshops in 2009 and 2011, and 26% of participants in 2010 and 2015. ECAMM workshops conducted in 2013 and 2018 had the highest rates with 71% and 81% of participants having raw data available, respectively.

Binary logistic regression was used to identify predictors for having raw data available. The country where the ECAMM workshop was conducted was significantly associated with having raw data available ($p<0.001$), with significantly lower odds of having raw data for ECAMM workshops conducted in Indonesia (OR 0.195, 95% CI 0.091 – 0.415), Kenya (OR 0.052, 95% CI 0.027 – 0.100), Thailand (OR 0.318, 95% CI 0.154 – 0.657), Uganda (OR 0.086, 95% CI 0.039 – 0.186), Vietnam (OR 0.07, 95% CI 0.030 – 0.165) and Other[1] (OR 0.295, 95% CI 0.174 – 0.503), compared to ECAMM workshops conducted in Australia. The year of the ECAMM workshop was also a significant predictor of having

[1] Includes Angola, Bangladesh, Bhutan, Cambodia, China, Eritrea, Ethiopia, India, Iran, Lao PDR, Madagascar, Mozambique, Myanmar, Nepal, Nigeria, Oman, Pakistan, Rwanda, Sri Lanka, Swaziland, Timor Leste, Vanuatu and Zimbabwe

raw data available, with the odds of having raw data increasing 1.54 fold (95% CI 1.45 – 1.63) each year.

Due to the association between ECAMM Level and country in which the ECAMM workshop was conducted, there was also an association between the availability of raw data and ECAMM Level (Pearson's Chi-square, $p<0.001$), with a higher proportion of Level 1 and a lower proportion of Level 4 in the subset of participants with raw data. For participants with raw data available, 33.3%, 30.4%, 15.3% and 21.0% achieved ECAMM Level 1, 2, 3 and 4, respectively. These values were 24.0%, 30.9%, 17.6% and 27.6%, respectively, for participants without raw data.

Appendix 1 – Summary of changes made to data

Preliminary data cleaning and consistency checking was conducted with a number of errors detected. Where there was sufficient information to correct the error, changes were made to the data. Where it was not possible to determine what the correct data should be, the problem was noted but no change made to the data. A summary of the identified problems is provided below.

1. Slide 45 in 2009 Kenya ECAMM (starting 20 Jul) have 'cs' against true 'NMPS' slide. Some participants have counts and others have 0. Looks like slide set used in 20 Jul workshop is the same as that used in 6 July Kenyan ECAMM which has slide 45 as 'NMPS'. Changed participant results to 'NMPS' for those with count = 0 and Pf for those with counts>0 (for 20 July workshop). Affects 2009 ID74 and ID85. And also ID95 from Kenya ECAMM staring 6 July
2. 2010 Angola ECAMM (starting 13 Sep) has 'cs' designation for Slide 56 but no designation for true species and true count is 0. Remove data for slide 56.
3. 2010 Thailand, Malaysia and Vanuatu ECAMM: Zero value for 'ScoreinParasiteDection' changed to missing for ID163 to ID207 as there is no data to say that parasite detection was actually done.
4. 2010 Thailand ECAMM (19 July), 2010 Vanuatu ECAMM (starting 9 Aug) and 2010 Malaysia ECAMM (starting 20 September) have 34 counting slides, 2 slides for detection and 21 for species ID. Counting slides contain different species. Think there is a problem with the slide identification in the Final ECAMM results
5. 2010 Thailand ECAMM – Slides 4, 7, 9, 18, 28, 32, 43, 51 have 'Pf' designation with count data for all participants however true slide type is 'NMPS'. Suspect true slide type is incorrect but cannot correct as there is no true count data.
6. 2010 Thailand, Malaysia and Vanuatu ECAMM slide 6, 23, 48 and 54 are designated as 'cs' with all participants having zero count. True slide type is 'Pv'. Removed 'cs' but have no data to replace it with.
7. Slide 55 in 2011 PNG ECAMM (Starting 20 Jun) has true count of 0 but designation of "N/A" while participants have "NMPS". Change true slide type to "NMPS". Affects 2011 ID131 to ID141
8. Slide 22 in 2012 Kenya ECAMM (Starting 5 Mar) has parasite count in species column for participants. Move to count column and add 'cs' to slide type. Affects 2012 ID130 to ID138
9. 2012 ID47 has count recorded as 0 for slide 18 but raw data shows count is 583. Correct count to 583.
10. 2012 ID147 has count recorded as 0 for slide 20 but raw data shows count is 2844. Correct count to 2844.
11. 2012 ID148 has count recorded as 0 for slide 20 but raw data shows count is 320. Correct count to 320.
12. 2012 ID149 has count recorded as 0 for slide 19 but raw data shows count is 1863. Correct count to 1863. 2012 ID149 also has count recorded as 0 for slide 20 but raw data shows count is 331. Correct count to 331.
13. 2012 ID150 has count recorded as 0 for slide 19 but raw data shows count is 1548. Correct count to 1548. 2012 ID149 also has count recorded as 0 for slide 20 but raw data shows count is 1094. Correct count to 1094.
14. 2013 PNG ECAMM (starting 7 Oct) slide 43 – all participants except one have very large counts (>100,000) when true slide count is 407. Suspect true slide count is not correct. Have removed calculated values for % error.
15. Slide 45 in 2014 Uganda ECAMM (starting 25 Aug) is listed as 'cs' but true result is 'NMPS'. Replaced 'cs' by 'NMPS' where count is given as zero by participant. Affects 2014 ID34 to ID45.

16. 2014 PNG ECAMM staring 28 April has no ‘cs’ designation for counting slides. Replaced ‘Pf’ with ‘cs’ for slides with parasite count data (slides 1, 5, 9, 11, 13, 16, 20, 24, 26, 28, 30, 36, 41, 43, 52)
17. 2014 PNG ECAMM (starting 8 Sept) Slides 43, 45, 47 and 50 have “Pos” as the true slide type. The slide set seems to match that used in Australian ECAMM starting 17 Nov which has these slides as ‘NMPS’. Change “Pos” designation to “NMPS”. Affects 2014 ID22 to ID33
18. Slides 14, 17 and 50 in 2015 Madagascar ECAMM (starting 16 Nov) had parasite count data for participant and true data in species column. Moved to correct column and added ‘cs’ to participant species id and ‘Pf’ to true result. Affects 2015 ID39 to ID50.
19. Slide 56 in 2016 Indonesia ECAMM (starting 3 Oct) had parasite count data for participant and true data in species column. Moved to correct column and added ‘cs’ to participant species id and ‘Pf’ to true result. Affects 2016 ID97 to ID108.
20. Slide 44 in 2016 Indonesia ECAMM (starting 10 Oct) has count data for all participants but slide type is ‘Pf’. Changed to ‘cs’
21. Slide 56 in 2016 Indonesia ECAMM (starting 10 Oct) had true parasite count data for in species column. Moved to correct column and added ‘Pf’ to true result. Affects 2016 ID74 to ID85.
22. Slide 54 in 2016 Indonesia ECAMM (starting 10 Oct) had true parasite result as NA. All participants had ‘NMPS’ as the results so NA changed to ‘NMPS’. Affects 2016 ID74 to ID85.
23. Slide 55 in 2016 Indonesia ECAMM (starting 10 Oct) had true parasite result as NA. All participants had ‘Pm’ as the results so NA changed to ‘Pm’. Affects 2016 ID74 to ID85.
24. Slide 55 in 2016 Indonesia ECAMM (starting 3 Oct) had true parasite result as ‘NMPS’. All participants had ‘cs’ with 0 for count. But raw data has non-zero counts. Not sure what data is correct so have not made any changes.
25. Slide 5 in 2016 Nigeria ECAMM (starting 15 Feb) had parasite count data for participant and true data in species column. Moved to correct column and added ‘cs’ to participant species id and ‘Pf’ to true result. Affects 2016 ID200 to ID211.
26. Slides 47 in 2016 Nigeria ECAMM (starting 15 Feb) had true parasite count data for in species column. Moved to correct column and added ‘Pm’ to true result (based on the fact that all participants had Pm as species). Affects 2016 ID200 to ID211.
27. 2016 PNG ECAMM (starting 17 Oct) – ECAMM slide type does not seem to match true slide type:
    a. Slides 14, 27, 32, 36, 41 and 51 listed as ‘cs’ but true result is ‘NMPS’. All participant counts are zero so change result to ‘NMPS’
    b. Slide 53 listed as ‘cs’ but true result is ‘Po’. All participant counts are zero so remove ‘cs’ (creates missing data as don’t know what parasite type participant response was)
    c. Slides 22, 24, 26, 33, 38, 42, 47 and 50 are listed as ‘Pf’ but all participants have count data so designation changed to ‘cs’
28. Slide 48 in 2017 PNG ECAMM (starting 17 Nov) has participant species as ‘Pf’ but has count data. Change species designation to ‘cs’. Affects 2017 ID 37 to ID48
29. Slides 33 and 36 in 2017 Kenya ECAMM (starting 2 Oct) had parasite count data for participant and true data in species column. Moved to correct column and added ‘cs’ to participant species id and ‘Pf’ to true result. Affects 2017 ID60 to ID71.
30. Slide 38 in 2017 Sri Lanka ECAMM (starting 26 Jun) has participant species as ‘Pf’ but has count data. Change species designation to ‘cs’. Affects 2017 ID179 to ID190
31. Slides 20 & 21 in 2017 Mozambique ECAMM (starting 3 Apr) have ‘cs’ against true ‘NMPS’ slide. Changed designation to ‘NMPS’. Affects 2017 ID257 to ID268
32. Slide 1 in 2017 Indonesia ECAMM (starting 20 Mar) has participant species as ‘Pf’ but has count data. Change species designation to ‘cs’.

33. Slide 38 in 2017 Indonesia ECAMM (starting 20 Mar) have 'Pf' against a counting slide. Changed designation to 'cs'. Affects 2017 ID269 to ID280
34. Slide 24 in 2017 Indonesia ECAMM (starting 13 Feb) have 'Pf' against a counting slide. Changed designation to 'cs'. Affects 2017 ID313 to ID324
35. Slide 12 in 2017 Indonesia ECAMM (starting 13 Feb) does not have any data for participant result (empty cells). Slide is negative. Empty cells count as an incorrect result. Calculated values are incorrect against database, but if 'NMPS' result is added to empty cells results agree. Change empty cells to 'NMPS'. Affects 2017 ID314 to ID324
36. Slide 38 in 2017 Sri Lanka ECAMM (starting 26 Jun) have 'Pf' against a counting slide. Changed designation to 'cs'.
37. Slide 24 in 2017 Nepal ECAMM (starting 10 Dec) and Indonesia ECAMM (starting 13 Feb) have 'Pf' against a counting slide. Changed designation to 'cs'
38. Slide 20 in 2017 Nepal ECAMM (starting 10 Dec). All participants have Pf designation with count data, however true slide type is Pf,Po. This ECAMM has one less counting slide than expected so suspect true slide type should be 'Pf' and designation should be 'cs'. However it appears that the same slide was used in ECAMMs in PNG (starting 11 Nov), Australia (slide 22), China (slide 22) and Solomon Islands (slide 22). In each of these workshops participants only did species (and got correct results) and not count. Unclear what the error is or how to correct.
39. Multiple participants: 'cs' slide has 0 for count but raw data shows a non-zero count. Have amended values in ECAMM_Count column to reflect raw data.

Discrepancies in data from different sources

Data for parasite detection, species identification and parasite count each appeared twice in the dataset: 'Final ECAMM Parasite Detection' and 'Score in Parasite Detection', 'Final ECAMM Parasite ID' and 'Species Identification', and 'Final ECAMM Parasite Count' and 'Parasite Count'. However the values did not always match as would be expected for duplicate data. Calculations of each outcome measure were also conducted using raw slide data (where available). The full list of discrepancies has not been reported. Rather examples are displayed below, with text in green identifying the values considered as correct. Where there was discrepancy between values in the dataset, the calculated value was used to determine the correct entry. If the calculated value did not match either value in the dataset then the data was change to a missing value.

- ID8 2010: FinalECAMMParasiteID = 71 vs SpeciesIdentification = 80; FinalECAMMParasiteCount=50 vs ParasiteCount=36 (Level 3)
    - Calculated as species ID = 79.2 & Count = 35.7
- ID65 2010: FinalECAMMParasiteID = 76 vs SpeciesIdentification = 79;
    - Calculated as species ID 78.8
- ID113 2010: FinalECAMMParasiteID = 90 vs SpeciesIdentification = 79;
    - Calculated as species ID 78.8
- ID130 2010: FinalECAMMParasiteID = 98 vs SpeciesIdentification = 95;
    - Calculated as species ID 97.5
- ID131 2010: FinalECAMMParasiteID = 99 vs SpeciesIdentification = 96;
    - Calculated as species ID 98.8
- ID133 2010: FinalECAMMParasiteCount=53 vs ParasiteCount=67
    - Calculated as parasite count 66.7
- ID152 2011: FinalECAMMParasiteID = 68 vs SpeciesIdentification = 65;
    - Calculated as species ID 66.7

- ID50 2012: FinalECAMMParasiteCount=41 vs ParasiteCount=59
    - Calculated as parasite count 52.9
- ID55 2012: FinalECAMMParasiteID = 77 vs SpeciesIdentification = 88; FinalECAMMParasiteCount=59 vs ParasiteCount=41
    - Calculated as species ID = 88.2 & Count = 41.2
- ID77 2012: FinalECAMMParasiteID = 80 vs SpeciesIdentification = 79; FinalECAMMParasiteCount=40 vs ParasiteCount=53
    - Calculated as species ID = 84.2 & Count = 35.3
- ID113 2012: FinalECAMMParasiteCount=73 vs ParasiteCount=71
    - Calculated as parasite count 73.3
- ID7 2013: FinalECAMMParasiteCount=47 vs ParasiteCount=48
    - Calculated as parasite count 46.7
- ID28 2014: FinalECAMMParasiteCount=71 vs ParasiteCount=72
    - Calculated as parasite count 71.4
- ID62 2014: FinalECAMMParasiteCount=33 vs ParasiteCount=30
    - Calculated as parasite count 33.3
- ID95 2014: FinalECAMMParasiteCount=50 vs ParasiteCount=40
    - Calculated as parasite count 53.3
- ID98 2014: FinalECAMMParasiteCount=53 vs ParasiteCount=50
    - Calculated as parasite count 53.3
- ID127 2014: FinalECAMMParasiteCount=63 vs ParasiteCount=53
    - Calculated as parasite count 53.3
- ID158 2016: FinalECAMMParasiteCount=57 vs ParasiteCount=50
    - Calculated as parasite count 57.1
- ID206 2016: FinalECAMMParasiteDetection=100 vs ScoreinParasiteDetection=0
    - Calculated as parasite detection 100

Appendix 2 – Summary of new variables created

Categorisation of position or designation of participant at time of ECAMM workshop

NEW CATEGORY REPRESENTING CURRENT POSITION	SELF-REPORTED PARTICIPANT DESIGNATION
Doctor / medical officer	Associate senior doctor Case management Clinician Consultant Hematopathologist Doctor Doctor-in-charge Dr. Full senior doctor Haematologist Medical Officer Medical/ER Superintend
Laboratory technician / scientist	4 Cyrus Njuguna 34 Male Kenya HND - MLT Acting Laboratorio Ag Principal CM Lab Officer Assist Lab Supervisor Assistant Inspector Assistant of Medical Lab Technologist Assistant of Science Officer Assistant Researcher Assistant Technologist Associate senior technologist Biomedical Laboratory Scientist BMLS Bsc - Medical Laboratory Scientist DIP. MLT Diploma - MLT District Senior Lab Technician Full senior technologist Graduate Scientific Officer Haematology Scientist HND - MLT Lab assist Lab Assistant Lab Coordinator Lab Manager Lab Scientist Lab staff Lab Supervisor Lab tech Lab Tech Lab Tech 1 Lab Tech CPL Lab Tech Gr 2 Lab Tech QC Officer Lab technician Lab Technician Lab technologist Lab Technologist Lab-Technician Lab, Malaria

	Lab. Assist. 5th Lab. Assistant Lab. Tech Lab. Tech Officer Lab. Tech. Lab. Tech. Officer Lab. Technician Lab. Techs Laborant Laboratory Assistant Laboratory Expert Laboratory Officer Laboratory Scientist Laboratory Specialist Laboratory Supervisor Laboratory Tech Laboratory Tech Grade 1 Laboratory Tech Grade 2 Laboratory Technician Laboratory Technician (1) Laboratory Technician Grade I Laboratory Technologist Med Lab Assistant Med Lab Scientist Med Lab Tech Med Lab Tech I Med Scientist Med Tech Med Tech 11 Med Tech II Med Tech III Med Technologist Med. Lab. Tech Medical (Lab) Technologist Medical Lab Scientist Medical Lab Technologist Medical Lab. Technician Medical Lab. Technologist Medical Laboratory Scientist Medical Laboratory Technologist Medical Laboratory Technologist04 Medical Research Technologist Medical science technologist Medical scientist Medical Scientist Medical technologist Medical Technologist Medical Technology Medtech II Medtech IV MLA MLS MLT MLT 1 MLT I MLT-I MLT1

	Msc - Medical Laboratory Scientist
	MT (Lab)
	MT II
	MT-II
	MT-III
	Path tech
	PHLT
	PHLT (contract basis)
	Principal Biomedical Scientist
	Principal Lab Technologist
	Principal Laboratory Technologist
	Public Health Lab Technician
	QLD Health
	Res. Officer
	Research Assistant
	Research Scientist
	Sc Res Spec I
	Science Officer
	Science Research Spec. 1
	Science Research Specialist
	Scientific Officer
	Scientific Officer-Malaria
	Scientist
	Scientist/LT
	Senior CM Lab Officer
	Senior Lab Tech
	Senior Lab technologist
	Senior Lab Technologist
	Senior Lab Technologist Arua Regional Ref Hospital Arua 778610499
	12 BIKUMBI PATRICK M Principal Lab Technologist
	Senior Lab-Technician
	Senior Laboratory Technologist
	Senior Med. Lab. Tech.
	Senior Medical Lab Scientist
	Senior Scientist
	SMT (Lab)
	Snr Science Research Spec.
	Snr Scientist/Trg Officer
	SO
	Sr. Lab Technician II
	Sr. Lab. Technician
	Sr. Lab. Technician II
	Sr. Lab. Technologist
	Sr. Technician
	SRS I
	SRS2
	Tech Officer
	Technical Assistant
	Technical Officer
	Technical staff
	Technician
	TECHNICIAN
	Technician biologist
	Technician Biologist
	Technician C
	Technician de labo
	Technician de laboratoire

	Technician Grade 1 Technicien biologiste TECHNOLOGIST Technologist-in-charge Tecnico l;aboratorio TO
Laboratory Head	Associate Chief Chief Chief, Field section, Dept of Immunology and Medicine Chief, Laboratory Section Chief, Standard Treatment Section Deputy Director Head BVBD Laboratory Head of Slide Checking Unit Head, Lab for Tropical Med Head, Lab Section Head, NRL Malaria Supervisor PTS Manager Unit Head
Microscopist	Clinical Pathologist Community Microscopist Facilitator Malaria Training Facilitator of Training Field Microscopist IDI Technical trainer Instructor JCT Pathology Lab Tech and Malaria Microscopists Lab Tech and Malaria Microscopists Walter-Reed Kisumu Lab Tech and Malaria Microscopy Trainer Laboratory Assistant (Microscopist) Malaria Microscopist Malaria Microscopy Trainer Malaria Microscopy Training Coordinator Malaria Researcher Malaria Senior Instructor Malaria Technician Microcopist Microscopiest Microscopist Microscopist (A/Lab Sup GSH) Microscopist (NRH) Microscopist (Senior, Trainer) Microscopist (Validator) Microscopist /Technician Microscopist & lab assistant Microscopist & Lab assistant Microscopist Technician Microscopist/Technician Microscopists Msc - Medical Parasitologist OIC Malaria Lab Parasitologist Pathologist PhD - Medical Parasitologist Primary examiner

	Senior Microscopist Slide checking Group SSO – Pathology TB/Malaria Microscopist
Programme Officer	Program Manager Programme officer Public health officer Public Health Officer Public Health Programme Mgr
QA / Quality officer	A/Chief QA/QC VBD Laboratory Chief, QA/QC VBD Laboratory Head, Cluster of QA, VBD Diagnosis Malaria Slide Cross Checker National Lab OIC-QA Unit QA Microscopy at Central Level QA Microscopy at Regional Level (Middle Part) QA Microscopy at Regional Level (North Part) QA Microscopy at Regional Level (South Part) QA Officer - MLS QA Officer / Parasitologist QA, Laboratory Technologist QM Quality Assurance Officer Quality control Quality Officer Researcher, Quality Officer, Malaria Focal Person Validator
Unknown / Other	A/Lab Sup ASO Assistant Pharmacist Assistant Professor Associate Professor biologist Biologist BMS Bsc - MLT BSMT Burkina Faso Burundi CAPT AR CNM Congo Brazza Coord Lab SSM Cote d'Ivoire DIP. SCIENCE District Lab focal Person DLFP Dr. DRC Ento II Entomologist Entomologist II Epidemiology Epidemiology Department Gabon

	Group leader Group Leader John-Bosco Edwomitozi LDC Lecturer Madagascar Malaria Focal Person Mali Miss MoH – Zambia Mr. Ms MS NHL Niger no data Nurse of MLA Nursing Project Officer Public Health Technician Researcher Senegal SHPO Special Services Assistant SPHO SRS 1 SRS 2 Staff Student Supervisor, Field Section The Comoros Training Coordinator Tuberculosis Focal Person Vet Officer Veterinarian/Scientist

List of Last Training which was considered WHO Refresher Training

The participant responses considered to represent refresher training are detailed below.

WHO REFRESHER TRAINING	LIST OF TRAINING LAST ATTENDED BY PARTICIPANT
Yes	Malaria Microscopy Refresher Training
	Malaria Microscopy Refresher Training (MMRT)
	Malaria Refresher
	Malaria Refresher Training
	Malaria Refresher Training - CPHL
	Microscopy QA Refresher
	Microscopy Refresher Training
	MM Refresher training, ROHFW, Jaipur, Rajasthan
	MMRT
	MMRT – Swaziland
	MMRT and ECAMM
	MMRT AND Malaria QA
	MMRT and Pre-ECAMM
	MMRT/ Facilitator MMRT
	MMRT/TOT
	Refresh training
	Refresher Course on Malaria Microscopy
	Refresher malaria microscopy
	Refresher Malaria Microscopy Training
	Refresher training
	Refresher Training
	Refresher Training for Malaria Microscopists (WHO SOPs)
	Refresher training, Nay Pyi Taw
	Refresher training, Yangon
	Refreshing Training of Microscopy
	Refreshment training Microscopy Malaria Bil 1/12 Pre-ECA Malaria WHO
	Refreshment training Microscopy Malaria Bil 1/12Pre-ECA Malaria WHO
	WHO Refresher Training (78% achieved)
	WHO Refresher Training (85% achieved)
	WHO Refresher Training (86% achieved)
	WHO Refresher Training (87% achieved)
	WHO Refresher Training (89% achieved)
	WHO Refresher Training (91% achieved)
	WHO Refresher Training (92% achieved)
	WHO Refresher Training (96% achieved)
	WHO Refresher Training (98% achieved)

Appendix 3

Number of participants from each country

PARTICIPANT COUNTRY	FREQUENCY	PERCENT
ANGOLA	12	.8
AUSTRALIA	91	6.1
BAHRAIN	1	.1
BANGLADESH	26	1.8
BHUTAN	23	1.5
BOTSWANA	7	.5
BURKINA FASO	1	.1
BURUNDI	2	.1
CAMBODIA	55	3.7
CHINA	58	3.9
COMOROS	1	.1
CONGO BRAZZA	1	.1
DR CONGO	1	.1
ERITREA	12	.8
ETHIOPIA	17	1.1
GABON	1	.1
GHANA	13	.9
INDIA	24	1.6
INDONESIA	62	4.2
IRAN	12	.8
IVORY COAST	1	.1
KENYA	82	5.5
LAO PDR	49	3.3
LIBERIA	7	.5
MADAGASCAR	13	.9
MALAWI	14	.9
MALAYSIA	61	4.1
MALDIVES	6	.4
MALI	1	.1
MOZAMBIQUE	12	.8
MYANMAR	42	2.8
NAMIBIA	4	.3
NEPAL	24	1.6
NIGER	1	.1
NIGERIA	22	1.5
OMAN	9	.6
PAKISTAN	12	.8
PAPUA NEW GUINEA	191	12.9
PERU/USA	1	.1

PHILIPPINES	71	4.8
QATAR	1	.1
RWANDA	12	.8
SAUDI ARABIA	1	.1
SENEGAL	2	.1
SOLOMON ISLANDS	72	4.8
SOMALIA	1	.1
SOUTH SUDAN	1	.1
SRI LANKA	30	2.0
SWAZILAND	18	1.2
TANZANIA	2	.1
THAILAND	73	4.9
TIMOR LESTE	24	1.6
UGANDA	85	5.7
USA	2	.1
VANUATU	43	2.9
VIET NAM	52	3.5
ZAMBIA	10	.7
ZANZIBAR	2	.1
ZIMBABWE	11	.7
Total	1485	100.0

WHO Technical Consultation on External Competence Assessment of Microscopists for Malaria

Dr A. Bosman

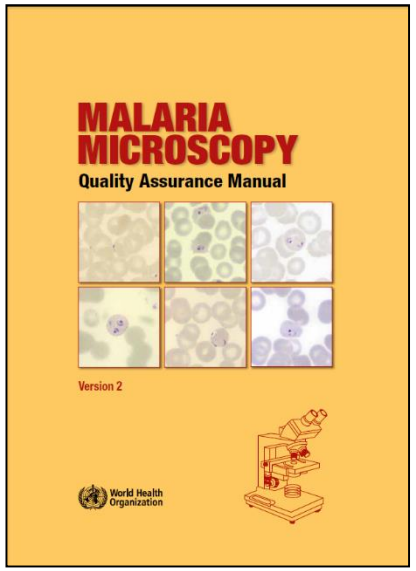
Malaria Policy Advisory Committee Meeting

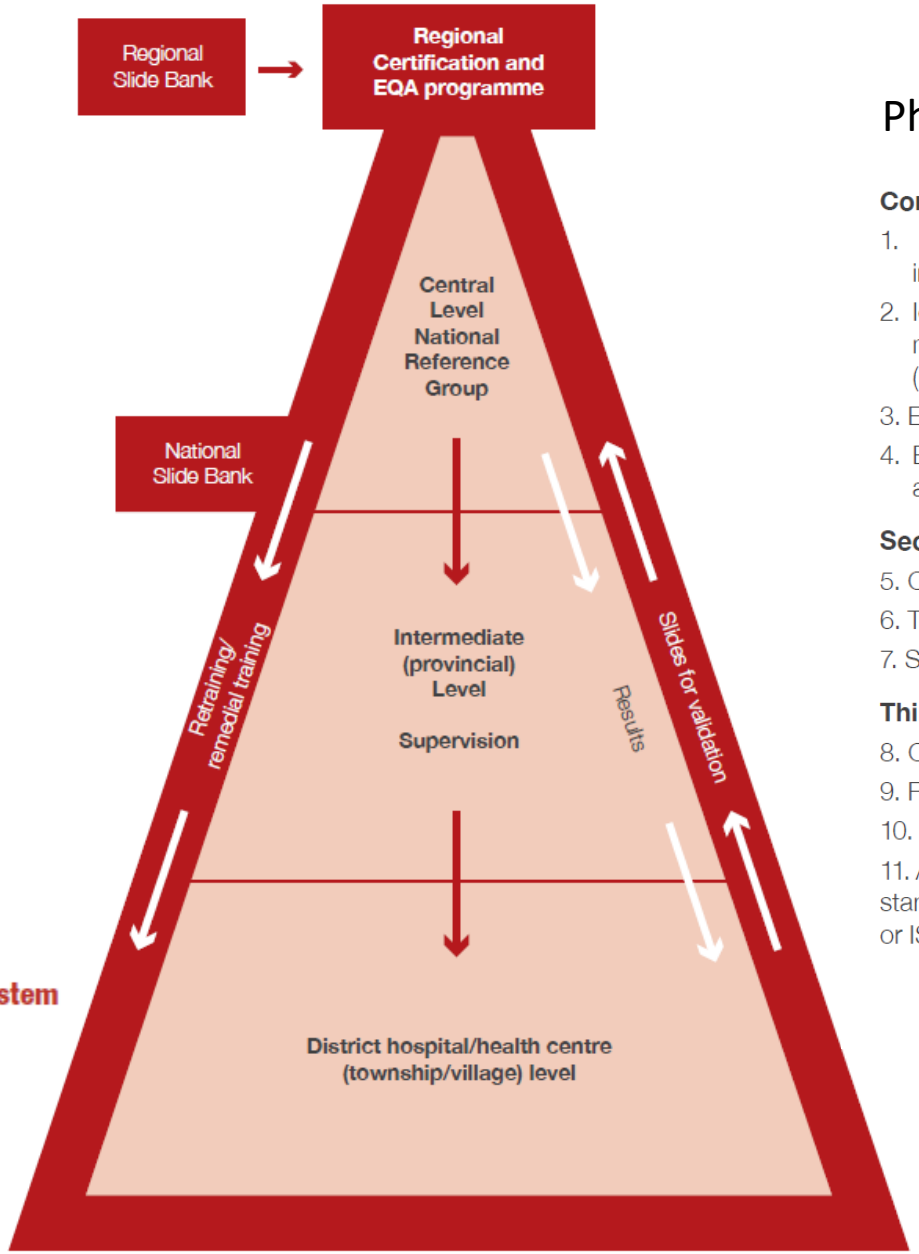
10-12 April 2019, Salle A, World Health Organization, Geneva, Switzerland

Global **Malaria** Programme

World Health Organization

Quality assurance of malaria microscopy





Structure and function of the quality assurance system

Phased implementation of the QA system

Core activities

1. Make a baseline situation analysis of the resources available in the country and gaps in commodities and infrastructure.
2. Identify the QA coordinator and a national core group of microscopists undergoing external competence assessment (ECA) and certified as WHO level 1 or 2.
3. Establish a national steering committee.
4. Ensure policies, guidelines, SOPs and associated commodities and infrastructure.

Second step

5. Competence assessment
6. Training
7. Supervision

Third step

8. Cross-checking
9. Proficiency testing
10. On-site evaluation
11. Accreditation of the diagnostic centre to international standards such as ISO 9001:2008, ISO 15189:2012 or ISO 17025:2005

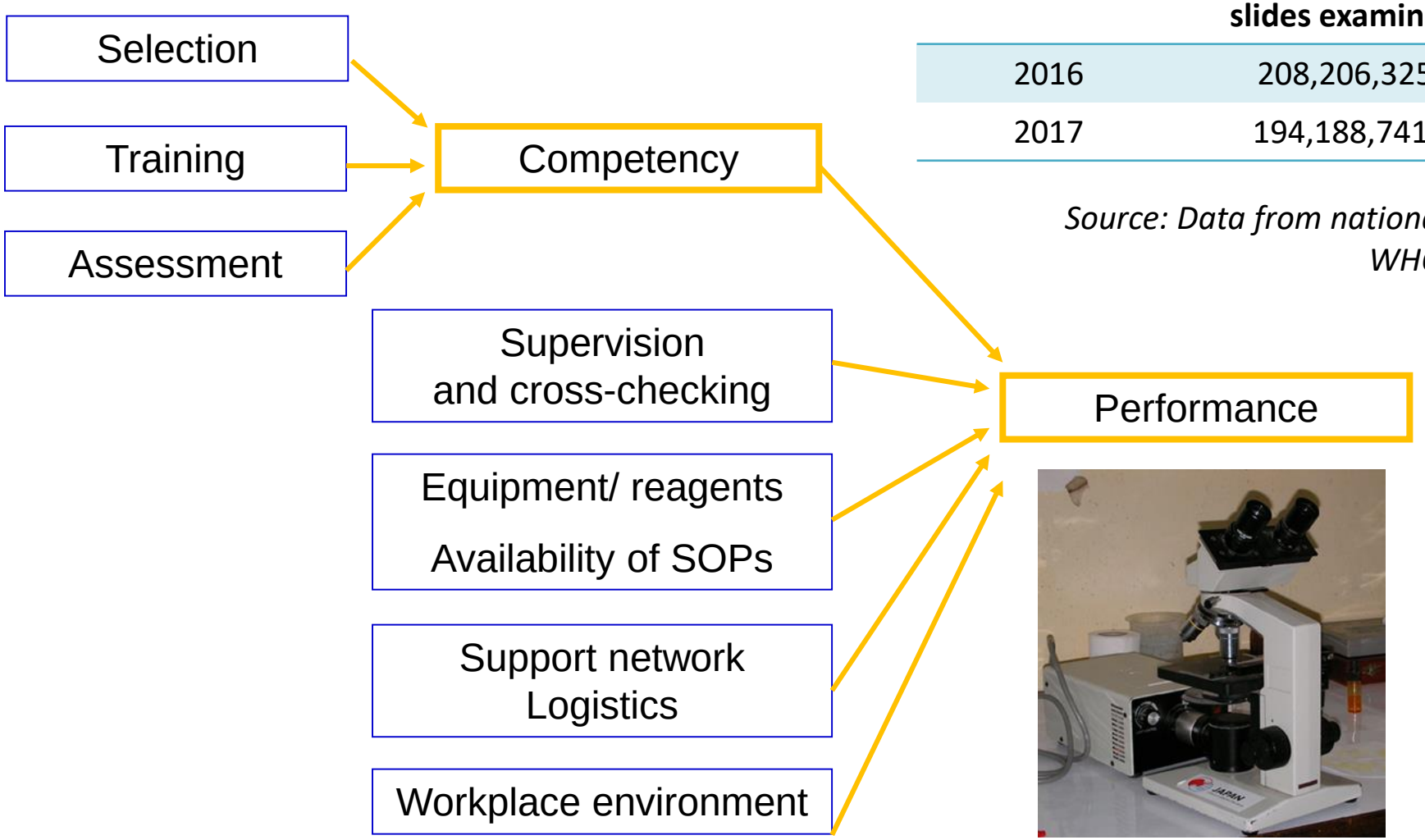
Core activities

Second step

Third step

Mature QMS

Determinants of microscopy performance

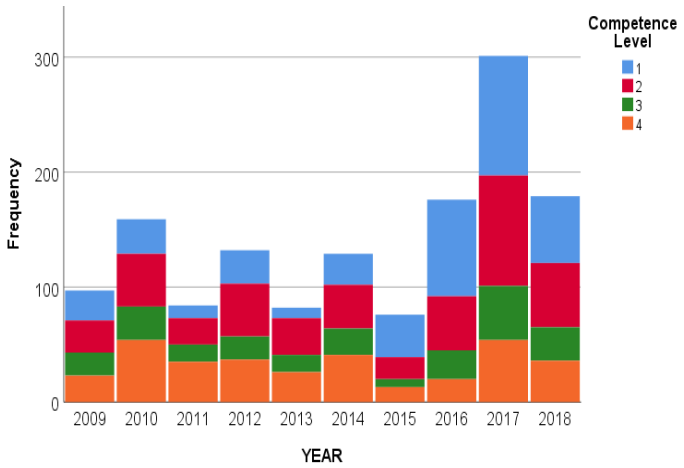


	Malaria microscopy slides examined	Malaria RDT examined
2016	208,206,325	184,256,672
2017	194,188,741	188,346,273

Source: Data from national malaria programs reported to WHO for World Malaria Report 2018

External competency assessment malaria microscopy

- The ECAMM scheme was initiated in 2005 the Philippines under the coordination of ACTMalaria and then expanded to multiple countries by WPRO and SEARO.
- Initial experiences were reviewed by WHO meetings of experts in 2006 and 2008 to define the assessment model which was implemented in 2009 and used up to today.
- It was expanded to countries in the WHO African Region in 2009 in collaboration with Amref Heath Africa primarily for Anglophone countries and in 2015 the University of Cheikh Anta Diop de Dakar (UCAD) primarily for Francophone countries. The first workshop was implemented in the WHO Eastern Mediterranean Region in 2016.
- Up to January 2019, 218 ECAMM workshops have been held. Since 2015, WHO has run 3 workshops to train 42 ECAMM L1 as potential facilitators, and there are currently 10 facilitators (7 for AFRO and 3 for non-AFRO) and a 18 potential facilitators that are currently being mentored.



ECAMM slide set composition

Post Assessment = 56 Slides				
Slide Set	**Slide Set**	**Day 1**	**Day 2**	**Day 3**
Negatives = 20 Slides	Negatives = **20 slides**	7 slides	7 slides	6 slides
Positives = 22 slides	Positive i.e *P. falciparum* = **10 slides**	3 slides	3 slides	4 slides
	Positive i.e Mixed infection = **4 slides**	2 slides	1 slides	1 slides
	Positive Species specific (*Pm*, *Po*, *Pv*) = **8 slides**	2 slides	3 slides	3 slides
Count = 14 slides	Count **(200 – 500)** = **6 slides**	2 slides	3 slides	1 slides
	Count **(501 – 2,000)** = **6 slides**	2 slides	2 slides	2 slides
	40,000 - 100,000 = 2 slides	1 slide	0 slide	1 slide

(These totals may vary from course to course)

Pre-Assessment = 18 Slides		
Slide Set	**Slide Set**	**Monday**
Negatives = 5 Slides	Negatives = 5 **slides**	5 slides
Positives = 8 slides	Positive i.e *P. falciparum* = **3 slides**	3 slides
	Positive i.e Mixed infection = **1 slide**	1 slide
	Positive Species specific (*Po, Pv*) = **4 slides**	4 slides
Count = 5 slides	Count **(200 – 500)** = **2 slides**	2 slides
	Count **(501 – 2,000)** = **2 slides**	2 slides
	40,000 - 100,000 = 1 slide	1 slide

External and national competence assessment

External competency assessment for malaria microscopists (ECAMM)

- Primarily targets national core group of microscopists (including National Reference Laboratory) or microscopists playing key QA roles in the NMP or other national institutions involved in QA of malaria microscopy
- Conducted by an external facilitator designated by WHO
- Only those who achieved Level 1 or Level 2 are certified on that Level (Level 3 and 4 achieved certificate of participation)
- Validity of certificates is 3 years
- Should be combined with some form of re-training


World Health Organization
Regional Office for the Eastern Mediterranean

CERTIFICATE OF COMPETENCE

Abdolwahab Dehghani

IS CERTIFIED
Level 1 Malaria Microscopist*

According to the WHO Standard**
in the
External Competence Assessment of Malaria Microscopy
from 16 to 21 May 2016

* This certificate is valid for three years from date of issuance
** WHO. Malaria Microscopy Quality Assurance Manual. Version 2 (2016)

Dr Ali Akbar Sayyari
Health Deputy, Ministry of Health of Iran

Mr Ken Lilley
Assessment Facilitator
WHO-Certified Level 1 Microscopist

Dr Sameen Siddiqi
WHO Representative in I.R. Iran


World Health Organization
Regional Office for the Eastern Mediterranean

CERTIFICATE OF PARTICIPATION

Abdolallah Sheyhaki

ACHIEVED
Level 3 Malaria Microscopist*

According to the WHO Standard **
in the
External Competence Assessment of Malaria Microscopy
from 23 to 27 May 2016

* This certificate is valid for three years from date of issuance
** WHO. Malaria Microscopy Quality Assurance Manual. Version 2 (2016)

Dr Ali Akbar Sayyari
Health Deputy, Ministry of Health of Iran

Mr Ken Lilley
Assessment Facilitator
WHO-Certified Level 1 Microscopist

Dr Sameen Siddiqi
WHO Representative in I.R. Iran

National competency assessment for malaria microscopists (NCAMM)

- Targets fully trained and experienced microscopists at subnational level
- Conducted by WHO certified Level 1 from the NCG/NRL, designated by NMP
- Certification is Grade A, B, C, D (to distinguish from ECA)
- Validity of certification is 3 years
- Should be combined with some form of re-training

Recommended roles based on competence assessment

Level achieved	Recommended roles
1	• May conduct **training of microscopists** at international, national and subnational levels *(this need additional training such as instructional skills development and advanced courses on malaria diagnosis)* • May conduct **assessment of microscopists at international level**, after being selected and deemed suitable, including completing the WHO ECAMM facilitator training course • May conduct **assessment of microscopists at national and subnational** levels *(this need additional training on how to conduct competency assessments, instructional skills development, and advanced courses on malaria diagnosis)* • May **conduct blinded cross-checking or validation of slides** at national/subnational levels • May **conduct supervisory visits** *(this may need additional training on supervision and management)* • May serve as **reference microscopist for therapeutic efficacy studies** of antimalarials *(this may need more advanced training on malaria diagnosis)*

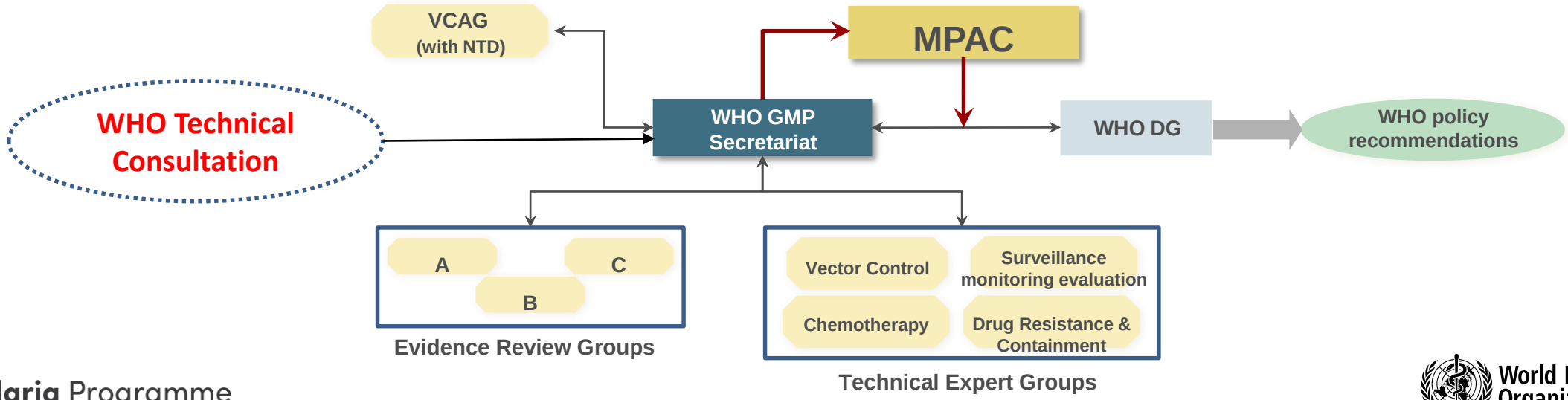
Recommended roles based on competence assessment

Level achieved	Recommended roles
2	• May conduct **training of microscopists at national/subnational levels** *(this need additional training such as instructional skills development and advanced courses on malaria diagnosis)* • May **conduct supervisory visits** *(this may need additional training on supervision and management)*
3	• May **provide assistance** to WHO-certified Level 1 or 2 during training of microscopists at national/subnational level
4	• Should not be involved in training, assessment and cross-checking of slides. Consider the need for refresher training on malaria microscopy.

Reference: WHO External Competency Assessment for Malaria Microscopists: Program Manual 2017

Preparations and process for the WHO Technical Consultation

- GMP/PDT has established a multiagency team to advise on ECAMM activities, including preparations for the technical consultation, including Dr J. Carter (Amref), Prof D. Ndiaye (UCAD) and Mr K. Lilley (Army Malaria Institute), and technical resource persons from the WHO AFRO, EMRO, PAHO, SEARO and WPRO.
- The technical consultation involved 20 participants, representing independent experts on malaria microscopy, lead facilitators of WHO ECAMM workshops and co-facilitators, experts in microscopy accreditation using different schemes (e.g. from the WHO Region of the Americas/Pan American Health Organization), and experts involved in microscopy training, accreditation, and development of SOPs.
- WHO commissioned analysis by Prof M. Gatton of WHO ECAMM workshops conducted from 2009 to 2018, involving 1485 participants from 59 countries attending 125 workshops completed in this period.



Objectives of the Technical Consultation

1. To review the results of ECAMM workshops conducted since 2009 by multiple institutions, and to evaluate the need for updating the current WHO criteria for certification of competence in relation to detection, species determination and parasite density calculation, including potential impact on certification levels if new criteria will be recommended for adoption.
2. To review experiences of combination of ECAMM workshops with different forms of microscopy refresher training, and provide guidance on the ideal mix of training plus assessment, as well as recommendations on revised curricula of the pre-ECAMM refresher training and the ECAMM workshops.
3. To review the variants of malaria microscopy SOPs for slide examination in relation to detection, species determination and parasite density calculation adopted by multiple agencies, taking into consideration the SOPs developed by WHO to foster harmonization around common SOPs.
4. To review e-learning platforms recently developed for malaria microscopy and their potential application for refresher training and self-assessment, in view of the potential wider dissemination and adoption of these learning tools.

ECAMM workshops

- The primary aim is to have an objective, formal assessment of the competence of malaria microscopists.

WHO competence levels and criteria

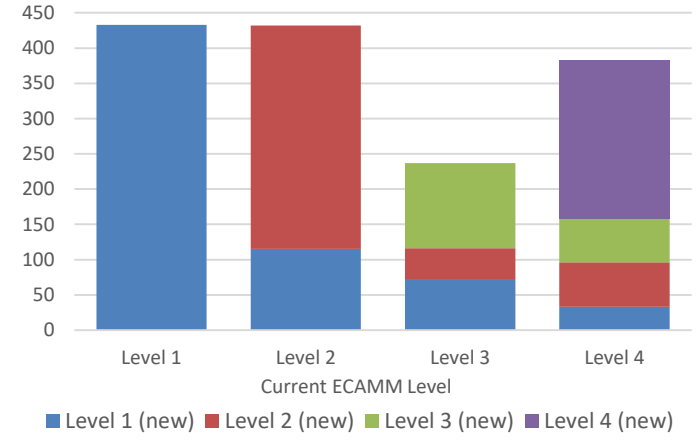
Competence Level	Parasite detection (%)	Species identification (%)	Parasite count within 25% of true count (%)
1	90-100	90-100	50-100
2	80-89	80-89	40-49
3	70-79	70-79	30-39
4	0-69	0-69	0-29

Conclusions of WHO Technical Consultation on ECAMM

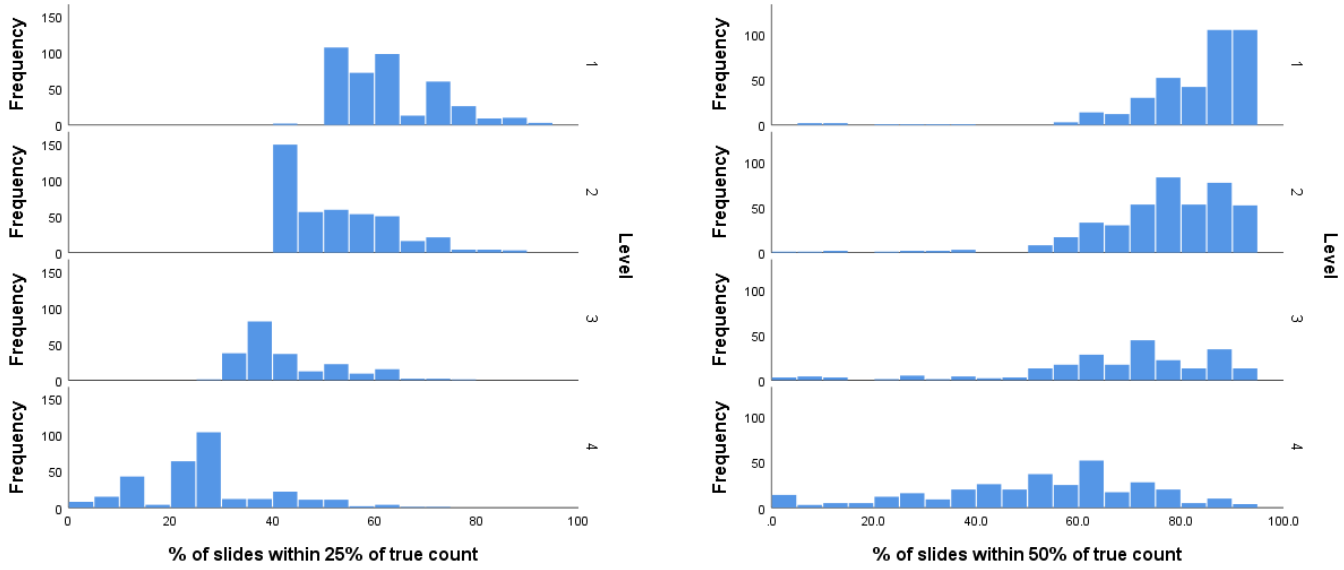
Objective 1: To evaluate the need to update criteria for competence levels.

a. Criteria for parasite counting should remain at a count of 25% within the true count instead of increasing to 50%, based on the analysis of the results of ECAMM workshops conducted from 2009 to 2018 to avoid a major change in levels of competencies and losing, with the current assessment method, the capacity to distinguish four different levels of competence.

Effect of changing quantification scoring scheme on level achieved



Distribution of counting scores with 25% and 50% cut-off



b. Scoring criteria for mixed infections will be changed, so that microscopists could be rewarded for identifying a second infection, even if they identify the wrong species. A new scoring system for mixed infections will be trialled until July and then reassessed. The analysis of the results of ECAMM workshops conducted from 2009 to 2018 showed that this change will result in an average change in species identification of –0.6% (range –3.7% to 2.5%), resulting in decrease in competence for 5.9% of current Level 1, 2 and 3 microscopists and increase of one level for 1.2% Level 4 microscopists.

New proposed scoring scheme for mixed infections:

- both species correctly identified = 1 (change from current scoring)
- 1 species correctly identified as single infection = 0.5 (change from current scoring)
- 2 species identified; one correct and one incorrect = 0.5 (change from current scoring)
- 2 species identified; both incorrect = 0

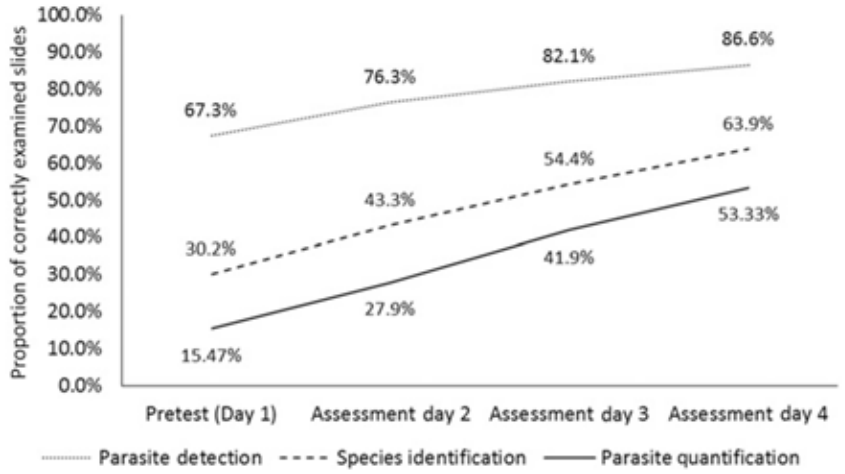
The rationale behind this new scoring is as follows:

- Complete correct answer = 1
- Each correct species = 0.5
- Identifying that two species are present = 0.5
- Identifying a species incorrectly = – 0.5

Day 1	0800–0915	0935–1010	1010–1300	1400–1430	1430–1700
Mon	Registration, administration, ECAMM structure and expectations	Pre-ECAMM theory test and feedback	Pre-ECAMM practical test (9 slides)	Microscope use and care	Pre-ECAMM practical test (9 slides)
Day 2	0800–0915	0935–1000	1000–1300	1400–1430	1430–1700
Tue	Review of practice slides	Parasite counting (1)	Test slide examination (10 slides)	Species revision	Test slide examination (9 slides)
Day 3	0800–0915	0935–1015	1015–1300	1400–1430	1430–1700
Wed	Review of test slides	Parasite counting (2)	Test slide examination (10) slides)	Blood elements and artefacts	Test slide examination (9 slides)
Day 4	0800–0915	0935–1015	1015–1300	1400–1430	1430–1700
Thur	Review of test slides	QA in malaria laboratory diagnosis	Test slide examination (10 slides)	Training-revision options	Test slide examination (8 slides)
Day 5	0800–0915	0935–1000	1000–1030		
Fri	Review of test slides	Current and future diagnosis	ECAMM evaluation and closing		

Assessment with test slides

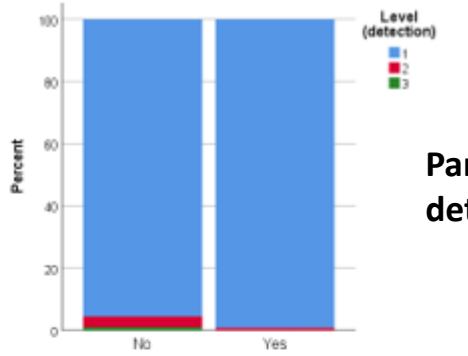
c. It was suggested to start the assessment for ECAMM on day 3, after participants had been given more teaching and practice on species identification and parasite density calculation.



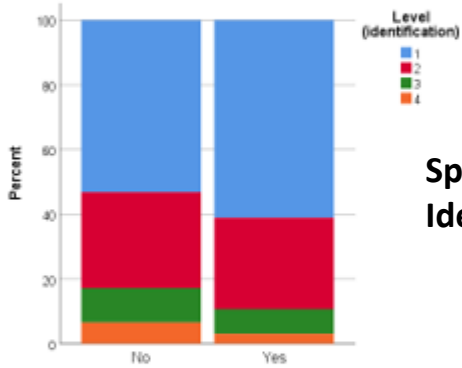
Conclusions of WHO Technical Consultation on ECAMM

Objective 2: To review experience & impact of pre-ECAMM refresher training (RT)

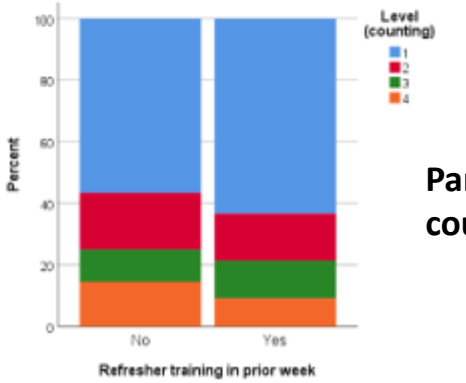
a. RT is an important and essential process and should continue to be conducted to increase skills and knowledge of participantss prior to ECAMM. Analysis of workshops conducted in Africa showed impact of pre-ECAMM RT on levels of ECAMM competences, but no association in the analysis of all ECAMM workshops. More attention on contents of RT and performance outcomes of ECAMM workshops.



Parasite detection

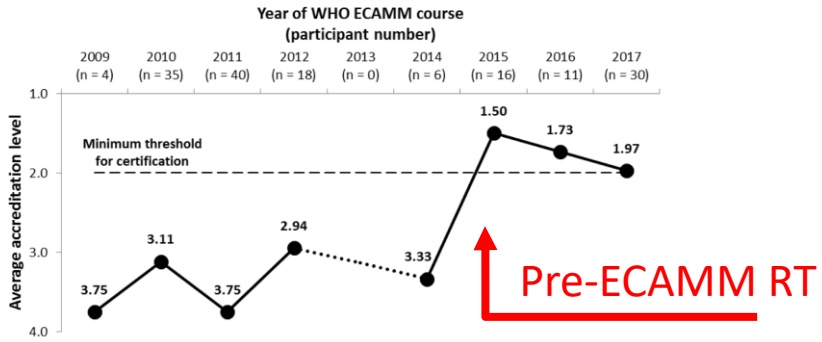


Species Identification

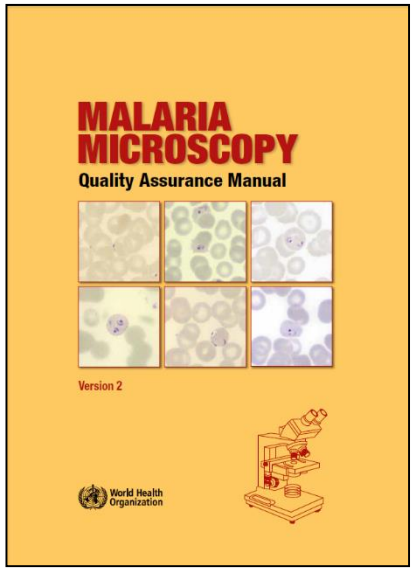


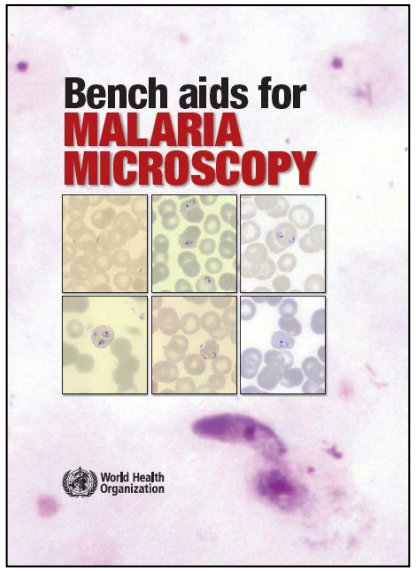
Parasite counting

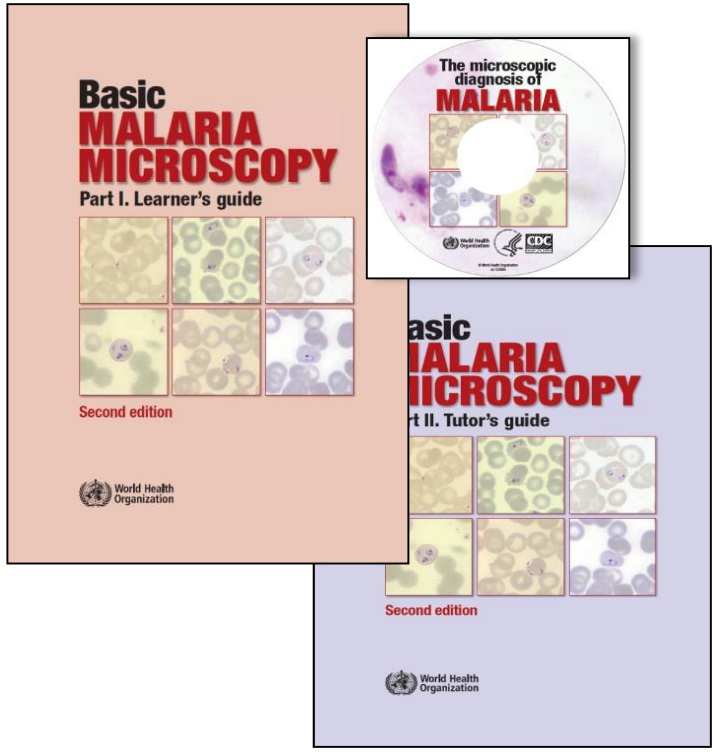
Worges *et al*. Am J Trop Med Hyg. 2019 Feb 19. doi: 10.4269/ajtmh.18-0361.



Harmonisation of ECAMM with WHO SOPs

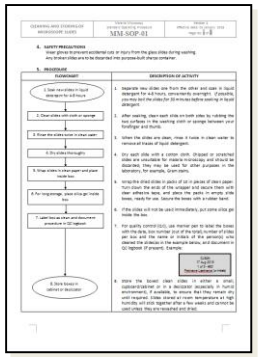


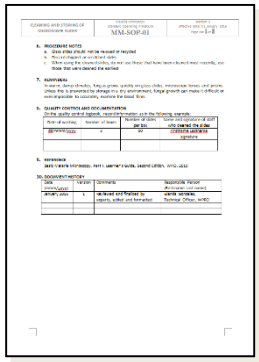




WHO SOPs for malaria microscopy for basic laboratory services :

1 - Cleaning and storing of slides
2 - Preparation of Giemsa stock solution
3a,b - Preparation of buffered water to pH 7.2
3c - QC of Giemsa and buffered water
4 - Preparation of Giemsa working solution
5a - Collection of finger-prick blood and preparation of blood film
5b - Collection of blood by venipuncture preparation of blood films from venous blood collected in tubes with anticoagulant
6a - Labelling of malaria blood films
6b - Recording and reporting of results
7a - Giemsa staining of malaria blood films
7b - Ebola virus inactivation during Giemsa staining
8 - Examination of blood film
9 - Parasite counting
10 - Preparation of dry blood spots
11 - General safety procedures
12 - Use and care of microscopes
13 - Management of wastes from malaria diagnostic tests



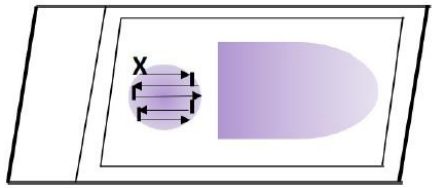


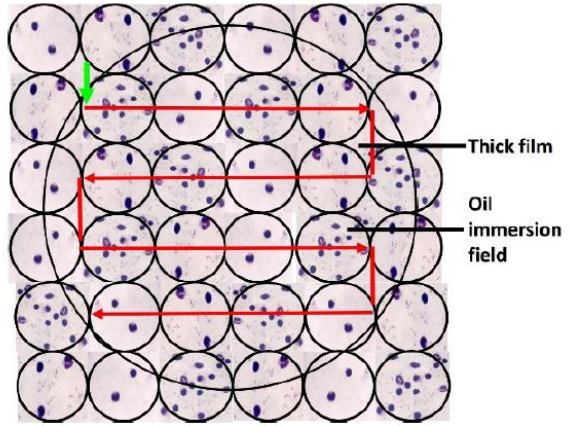
Conclusions of WHO Technical Consultation on ECAMM

Objective 3: Hamonisation of WHO SOPs for Malaria Microscopy and ECAMM

a. A study should be conducted to evaluate results with examination of the thick film by contiguous fields or every 5th field, and the results should inform the need for updating the current malaria microscopy SOPs. A small working of meeting participants will develop the study protocol.
b. Examination of 100 HPF of thick film is sufficient for detecting malaria parasites in the ECAMM workshop and for examination of patients with clinical malaria. The examination of 200 fields is relevant for research on low density parasitaemia.
c. Counting of parasites should be based on asexual parasites only
d. Counting of parasites in HPF of thick film should start at the first parasite seen

Fig. 1. Examining a thick blood film



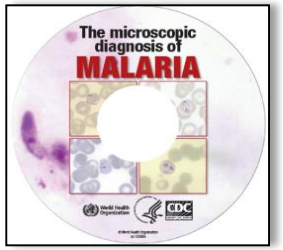


Conclusions of WHO Technical Consultation on ECAMM

Objective 4: To review malaria microscopy e-learning tools

a. E-learning tools could improve competence and address some of the challenges in RT of malaria microscopists. In particular, the remote location of most microscopists, and the costs and difficulties involved in leaving the workplace to attend training, could be compensated for by having training tools that are accessible at all times.
b. Such tools are intended to adjunct to training rather than an alternative to hands-on training. Their principal limitation is the requirement for access to a computer and projection equipment for group learning, and the lack of real-life training on manual microscope use and slide preparation.
c. The two tools reviewed, the CD-ROM on microscopic diagnosis of malaria and the WorldWide E-Learning Course on Malaria Microscopy (WELCOMM) can be used for learning and self-assessment.

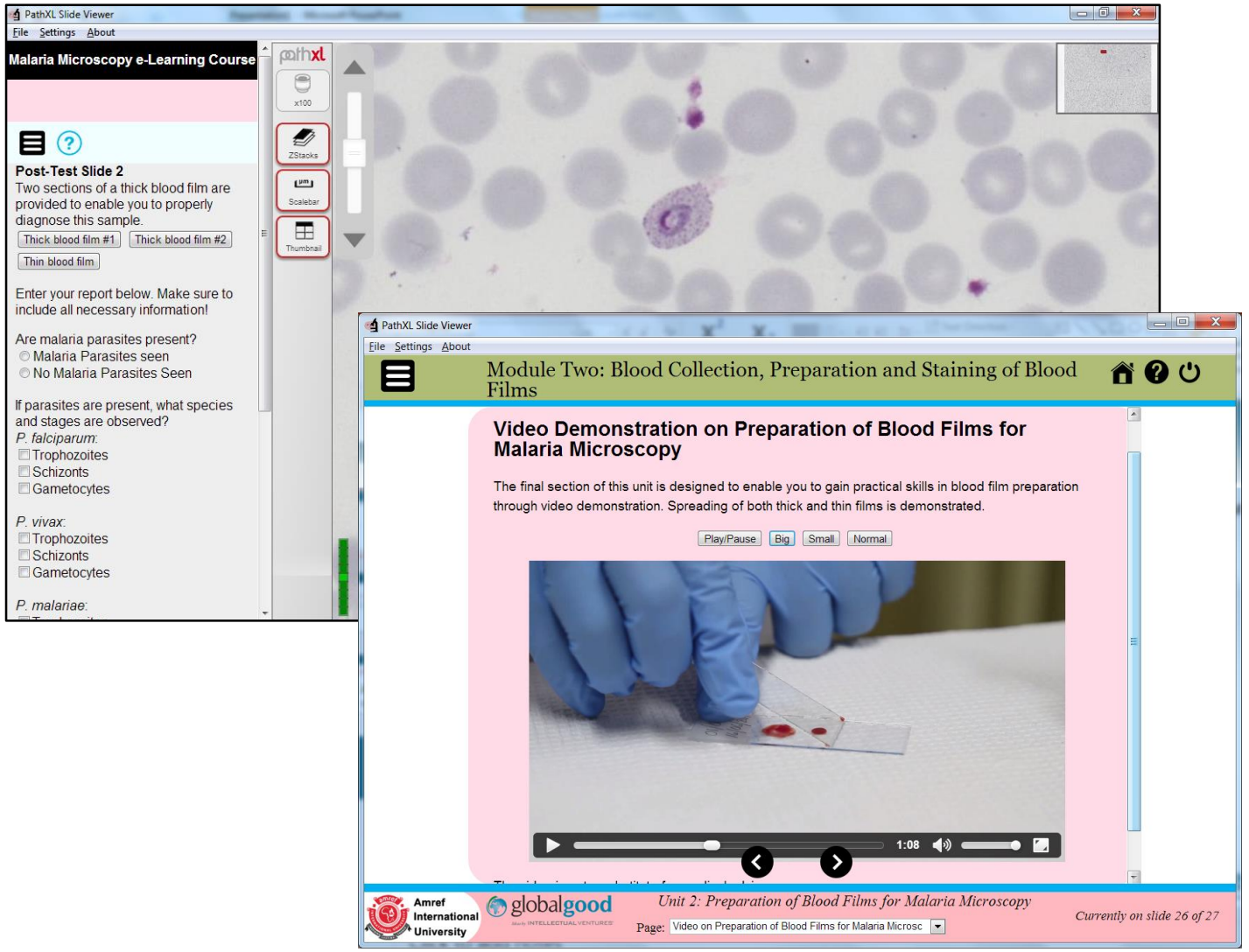
Free download of the CD_ROM from WHO/GMP website
https://www.who.int/malaria/areas/diagnosis/microscopy_cd_rom/en/



Aims of the WELCOMM course

Make skill improvement readily accessible to all microscopists on their own time

- Structured approach to learning: combines theory and practical
- Content: all aspects of malaria microscopy
- Provide self-improvement prior to taking accreditation courses (e.g. WHO ECA)
- Measurement of performance: quizzes & exercises after each module
- Certification: available on request
- Continuing Professional Development credits: in process
- Affordable course fees
- Sustainability – assured support for website maintenance and course management



Many thanks for your kind attention