Workshop

ARBOVIRUSES IN LATIN AMERICA AND THE CARIBBEAN: STRATEGIES AND CHALLENGES FOR PREVENTION AND CONTROL

Miami, May 23rd, 2018

Proceedings

Partners

Pan-American Health Organization PAHO / World Health Organization WHO

Latin American Society of Pediatric Infectious Diseases SLIPE

Chair

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Global Health Consortium

Agenda

8:15-8:30	**Opening** **Meeting Objectives** **Dr. Carlos Espinal, GHC, Dr. José Luis San Martín, OPS/OMS**
Session 1: Epidemiology of Arboviruses in the Americas • **Dengue scenarios** • **Update on zika, chikungunya** • **Potential introductions of other arboviruses** **Moderator: Dr Carlos Espinal, GHC/FIU**	
8:30-8:55 **8:55-9:20** **9:20-10:15**	Presentation: Epidemiological context and dengue scenarios Dr. José Luis San Martín, OPS/OMS Presentation: Current situation of zika and chikungunya in the region Dr. Thais dos Santos, OPS/OMS General Discussion
10:15-10:35	BREAK
Session 2: Epidemiological surveillance of Arboviruses. • **Transition from the dengue to the Arbovirus Integrated Management Strategy** • **Update on Surveillance Program** **Moderator: Dr. Diana Rojas, University of Florida. Dr Joao Bosco, Universidad de Goiás, Brazil**	
10:35-11:00 **11:00-11:40** **11:40-12:10** **12:10-12:30**	Presentation: Generic protocol for integration of dengue and other arboviruses. Dr Gamaliel Gutierrez Castillo Presentation: Country experiences: Mexico • Challenges, obstacles and proposals for dengue and arbovirus surveillance Dr. Jose Cruz México Presentation: The challenges of dengue and zika diagnosis in areas of co-endemicity Dr. Jorge Munoz, CDC, Puerto Rico. Discussion, conclusions
12:30-1:30 PM	LUNCH

Session 3: Integrated Management of Vector Control • **Regional strategies** • **Protocols for evaluating new technologies for vector control** • **Design, implementation, and evaluation of new interventions** **Moderator: Dr. Haroldo Bezerra PAHO**	
1:30-2:00	Presentation: Integrated Vector Management: A regional view Lic. Haroldo Bezerra, OPS/OMS
2:00-3:15	Moderator: Dr. Milena Mazarri New technologies in the Americas: Irradiated mosquitoes, Wolbachia, transgenic mosquitoes Presentation: Advances on the Wolbachia experience in Medellin, Colombia. Dr. Iván Darío Velez, PECET, Universidad de Antioquia, Colombia Presentation: Dispersing stations of Piriproxifen Sérgio Luiz Bessa, Fundación Oswaldo Cruz, Brazil Presentation: Development project on sterile mosquitoes to reduce the density of Aedes aegypti in selected communities Dr Jesus Felipe Gonzalez, Director CENAPRECE, México Conclusions
3:15-3:40	BREAK
Session 5: Should we prepare for high impact dengue epidemics? **Moderator: Dr. Carlos Espinal, GHC, FIU**	
3:40- 4:05 **4:05-4:30** **4:30-5:30**	Presentation: Potential critical dengue and arbovirus scenarios. Liliana Sanchez, CDC Dengue Branch, Puerto Rico Presentation: Value of modeling in the dinamics of arbovirus transmission Dra Diana Rojas, University of Florida, US Workgroups (2): Should we prepare for high impact dengue epidemics? • Strategies to mitigate the dengue morbidity and mortality impact • How to anticipate these potential scenarios in vector control programs? Group discussion, conclusions
5:30	Conclusions and closing of meeting Dr. Carlos Espinal, Director, Global Health Consortium, FIU

Objectives

The objectives of the Arbovirus workshop were:

1. To discuss the dengue epidemiology and potential scenarios for the next years.
2. To update the participants on the zika and chikungunya epidemiology and disease burden
3. To review the PAHO arbovirus strategy, challenges and opportunities in the transition from dengue to arbovirus integrated management strategy, including the new technologies for vector control.
4. To review the advances on the implementation of the dengue generic protocol in the region

General overview of the workshop development

The workshop was very successful in terms of the number of participants including representatives and experts on dengue and arbovirus, vector control, epidemiology and laboratory from Latin America and the Caribbean, and USA. In addition, a selected group of speakers with great expertise participated in each one of the thematic areas discussed in the agenda.

- Number of participants: 80
- Countries represented from Latin America and the Caribbean and US: 31
- PAHO members: 4
- CDC members: 2

Introduction

Dengue virus is considered a major international public health concern. During the past 50 years, the incidence of dengue has increased 30-fold. Up to 100 million new infections are estimated to occur annually in tropical and subtropical areas of the world, with documented further spread to previously unaffected areas. It is also estimated that nearly half the world's population live in countries where dengue is endemic.

Dengue is caused by any of the four dengue virus serotypes (DENV-1 to 4), a RNA virus of the family Flaviviridae. *Aedes* mosquitoes, primarily *Aedes aegypti* and *Aedes albopictus* transmit the disease. The infection can result in a broad spectrum of ailments, ranging from a self-limited illness, to a potentially lethal complication or severe dengue, such as dengue hemorrhagic fever/dengue shock syndrome (DHF/DSS). An estimated 500,000 people with severe dengue require hospitalization each year, a large proportion of whom are children. Without rapid and correct therapy, severe dengue case fatality rates can exceed 20% (WHO, 2012b). Medical treatment by providers experienced with the effects and progression of dengue can reduce mortality rates to less than 1%. The economic impact of dengue in the Americas is estimated at $2.1 billion (USD) per year on average.

However, since the 1990s, the Americas have experienced a sharp increase in the incidence of both dengue and dengue hemorrhagic fever (DHF). The Americas reported over 4.7 million dengue cases from 2000–2007 compared with 3.76 million cases for the period of 1980–1999. dengue incidence nearly doubled between the 1990s (35.9/100,000 population) and 2000s (71.5/100,000). Correspondingly, the number of DHF cases in the Americas increased from 58,419 (0.8/100,000) during the 90s, to 111,724 (1.7/100,000) during 2000–2007. The increasing trend in the Americas region continued in recent years, with dengue cases rising nearly three-fold from 857,534 cases in 2008 to 2.3 million during 2016. The year 2016 was characterized by large dengue outbreaks with Brazil alone contributing slightly less than 1.5 million cases, approximately 3 times higher than in 2014. The region also reported 1,032 dengue-related deaths.

Arboviral diseases of concern in Latin America include chikungunya, dengue, and zika. Dengue remains the most prevalent arbovirus in the region, but the recent introductions of chikungunya and zika highlight the regional vulnerability to arboviral diseases. The overlapping initial symptoms of these diseases pose a challenge for clinical diagnosis and underscore the importance of effective surveillance and laboratory diagnosis. To effectively manage the spread of these vector-borne diseases, an integrated management strategy that utilizes strengthened epidemiology, laboratory, patient care, integrated vector management, environment and entomology will be necessary.

During 2017, however, there has been a noticeable reduction in dengue incidence within the Americas. In comparison to 2016, the number of total dengue cases reported in this region during 2017 has fallen by 80%; as of October 6th, 2017 a total of 460,583 cases were reported, compared to 2,156,946 cases reported in 2016 during the same time period. This is the lowest since 2006 when 537,412 cases were reported. Moreover, the number of severe and fatal dengue cases during 2017 is the lowest since the Region's Integrated Management Strategy for dengue prevention and control in the Americas was implemented in 2003. Belize, Guadalupe, St. Martin, French Guiana, and Peru are the only countries in the Americas which have observed increases in dengue cases during 2017 compared to 2016.
It is currently unknown whether control measures will reduce the magnitude of the epidemic, and if so, when should such measures be initiated to reduce the risk of large dengue outbreaks developing.

Proceedings

Session 1
Epidemiology of Arboviruses in the Americas

Epidemiological context and dengue scenarios

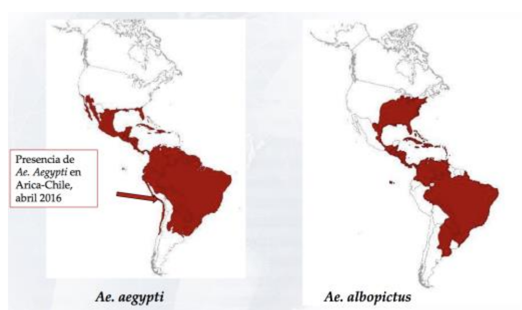
José Luis San Martín, MD
Regional Advisor, Arboviral Diseases, PAHO/WHO

Dengue, a mosquito-borne virus transmitted mainly by *Ae. aegypti*, is a major public health issue in Latin America and the Caribbean. Morbidity and mortality in this region have increased substantially in the last decade. The trajectory of dengue outbreaks in the Americas was categorized in four phases:

1. Introduction of dengue in the Americas (1600–1900)
2. Continental plan for the eradication of *Ae. aegypti* (1947–1970)
3. *Ae. aegypti* reinfestation (1971–1999) caused by the failure of the mosquito eradication program, followed by a
4. Continental plan to intensify the fight against the vector (1996-97) which failed due to an increased dispersion of *Ae. aegypti* and dengue virus circulation (2000–2010) characterized by a marked increase in the number of outbreaks.

Dengue outbreaks have also been attributed to *Aedes albopictus* and several species of the *Aedes scutellaris* complex. Each of these species has a particular ecology, behaviour and geographical distribution. *Ae. albopictus* is primarily a forest species that has become adapted to rural, suburban and urban human environments. Figure 1 shows the geographical spread of *Ae. aegypti* and *Ae. albopictus* in the Americas, as of 2011.

Figure 1. Geographical spread of the vector

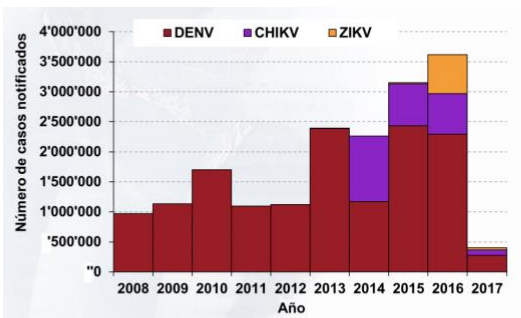


Source: Adapted from "Preparedness and response for an eventual introduction of chikungunya virus introduction in the Americas". CDC / PAHO, 2011

In recent years, the appearance of new arboviruses such as zika and chikungunya, in addition to the already endemic dengue and yellow fever, presented a challenge for the health systems, urging countries to improve clinical and laboratory diagnosis, epidemiological surveillance, and control of mosquito populations.

The epidemic curve of arboviral diseases in the Americas in the last decade shows viral co-circulation (chicungunya first reported in December 2013 and zika in August 2015). A very significant decrease in all arboviruses occurred in 2017 (Figure 2).

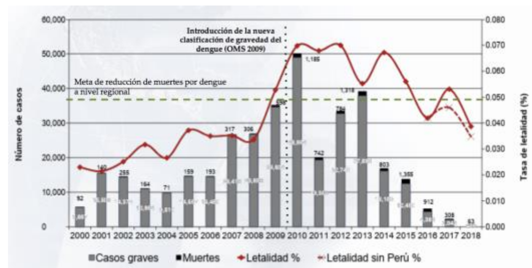
Figure 2. Epidemic curve, reported cases of dengue, chicungunya and zika in the Americas, 2008-2017



Source: PAHO country reports

In 2017, a significant reduction was reported in the number of dengue cases in the Americas: from 2,177,171 cases in 2016 to 584,263 cases in 2017. This represents a reduction of 73%. Panama, Perí and Aruba were the only countries/territories that registered an increase in cases during 2017. Similarly, a 53% reduction in severe dengue cases was also registered during 2017. In the first quarter of 2018, a reduction of 27% of reported cases was registered, compared with the same period in 2017. In early 2018 Paraguay and Argentina reported dengue outbreaks (Figure 3).

Figure 3. Number of severe cases, deaths and mortality rate from dengue in the Americas, 1980-2018*



** Source: Country information sent to PAHO/WHO, EW 19/2018*

The reduction in dengue cases in the Americas may be explained by three hypothesis:

1. Changes in epidemiological surveillance, but:
   - Epidemiological surveillance systems are not similar in all countries. There have been no major changes in surveillance systems in 2017.
   - Health systems detect dengue cases and severe cases; the latter decreased significantly, thus it is not likely they have not been reported.
   - A sudden operating problem in surveillance systems is possible; but not in all countries simultaneously.

2. Temporal or lasting crossed-immunity caused by the co-circulation of arboviruses, but:
   - Crossed reaction does not necessarily imply crossed protection.
   - Animal models suggest that previous dengue infection prevents people infected with zika to get sick. Could this also work inversely?

3. Changes in vector density and competence, but:
   - Vector control measures have recently been intensified
   - There are new control strategies
   - The impact is unknown

Should we prepare for high impact dengue epidemics? Three potential scenarios could derive from this complex epidemiological context:

Scenario 1. Dengue reemerges explosively in 2019, but with moderate severity and mortality; the process of protective crossed immunity is short-lived. The availability of sources of infection increases with the decrease in protective immunity. The intensity of the epidemic will depend on the predominant serotype. The severity and lethality could be moderate although it will depend on the humoral immunity accumulated in the population and the circulating dengue strain. The protection crossed by zika infection is almost null.

Scenario 2: The number of cases remains stable in the next 3 to 5 years, followed by explosive re-emergence of cases at the end of the period with an increase in severe cases and also increased risk of death, probably due to a zika / dengue temporary cross-immunity process lasting from these 3 to 5 years. The simultaneous circulation of more than one serotype could be synonymous of severity and deaths, because of the known history of cases in the region and the immunological response in sequential infections that lead to severity.

Scenario 3: Dengue and zika cases keep decreasing in the next 10 years, with sporadic outbreaks (severe cases and deaths), in countries where the cumulative number of susceptible individuals is very high. The process of cross-immunity is durable over time and keeps the incidence low. The availability of sources of infection decreases considerably. The cases most vulnerable to severe infection are those that have some predisposing factors (associated chronic diseases, older adults, immune problems, comorbidity, etc.).

Conclusion

Scenarios 1 and 2 are the most likely to occur: dengue epidemics with low levels of zika circulation. Strengthening dengue surveillance and developing preparedness plans for emerging of dengue and other arboviral diseases is imperative as well as designing and implementing novel interventions for vector control. Laboratory testing should be improved, with special focus on rapid diagnosis. It is expected that dengue vaccines will be a potential tool to complement an integrated disease management strategy.

Current situation of Zika and Chikungunya in the Americas

Thais dos Santos

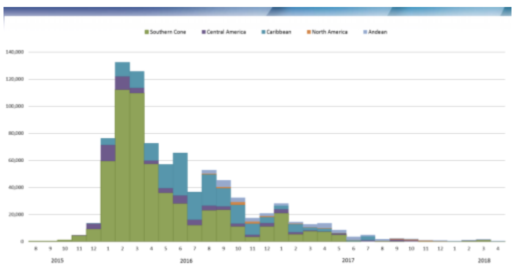
Advisor on Surveillance and Control of Arboviral Diseases Neglected, Tropical and Vector-Borne Diseases Unit Communicable Diseases and Environmental Determinants of Health Department Pan American Health Organization

Zika

In May 2015 the first case of zika virus disease was diagnosed in the continental region of the Americas, in the State of Bahia, Brazil. This confirmation came following months of detections of clusters of rash illness in the northeast of Brazil. Soon after the detection of cases of zika, clinicians in the areas of virus circulation also detected a marked increase in neurological disorders, such as Guillain–Barre syndrome and microcephaly, with evidence that many of the mothers of these children had experienced a febrile rash during their pregnancies.

To date, 48 countries and territories in the region of the Americas have confirmed autochthonous, vector-borne transmission of zika virus; about 50% of these countries and territories have reported increases in the detection of Guillain-Barre syndrome congenital syndrome associated with zika virus infection (Figure 4).

Figure 4. Monthly zika cases reported to pAHO by sub-region. August 2015-April 2018.



Zika has caused major epidemics in most countries but transmission has slowed down. The cumulative incidence by sub-region, in a comparison of EW 1-17 for 2016, 2017, and 2018 shows the significant decrease reported in each sub-region (Table 1).

Table 1. Zika cumulative incidence by sub-region (per 100,000 pop). EW 1-17 for 2016, 2017 and 2018

Sub-Region	EW 1-17, 2016	EW 1-17, 2017	EW 1-17, 2018
South America	80.40	6.13	0.84
Central America	60.86	6.71	1.04
Caribbean	90.25	18.88	0.11

Chikungunya

Chikungunya caused explosive, time-limited transmission in the Caribbean islands, but has persisted longer in continental land mass. The greatest case burden was reported by Brazil, with 26,475 total cases (15,684 confirmed) (Table 2).

Table 2. Chikungunya transmission in 2018. Countries in Latin America reporting the greatest case burden.

Country	Suspected	Confirmed	Total	Cumulative Incidence (per 100,000 pop)
Brazil	10,791	15,684	26,475	12.53
Colombia	6	220	226	0.46
Peru	216	N/A	216	0.67
Bolivia	116	34	150	1.36
Nicaragua	96	21	117	1.88

Conclusion

The current epidemiological profile of arboviral diseases shows that chikungunya transmission, although significantly reduced in 2017-2018, has persisted in the continent. Zika has caused major epidemics in most countries but transmission has also slowed down. There is also a reduced transmission of dengue fever post zika and resurgence of yellow fever. Surveillance systems need to adapt to the new epidemiological scenario, focusing on long-term sustainability and optimizing the use of resources in light of waning interest. Countries should assess the feasibility of integrating surveillance of arboviruses and evaluate if surveillance could be more sustainable if integrated to existing measles and rubella systems. Existing data sources should be maximized to quantify the burden of severe outcomes like neurological anomalies, birth defects, and persistent rheumatic disorders; innovative approaches such as modeling should be adopted, and continued information sharing, even in light of waning interest should be promoted.

Session 2
Epidemiological surveillance of Arboviruses

Generic protocol for integration of dengue and other arboviruses

Dr. Gamaliel Gutiérrez Castillo, MSc

The goal of this protocol is to achieve an integrated system of epidemiological surveillance of arboviruses to optimize the analysis of information thus improving decision making to impact on prevention and control actions.

Eight countries are currently participating (Figure 5). The protocol is based on case reporting standardization (probable or confirmed) under two surveillance approaches, national and sentinel, and the use of environmental and entomological drivers.

Figure 5. Generic protocol for integration of dengue and other arboviruses. Member countries.

National surveillance should focus on early detection of cases and outbreaks, describing the trends, time and geographical case distribution and particularly detecting deaths and unusual cases by weekly reports. Sentinel surveillance should characterize the disease burden based on clinical severity and viral serotype, monitoring the effectiveness of clinical management and integrating the analysis of environmental and entomological surveillance by monthly reports.

Regional dengue surveillance is carried out through the Health Information Platform for the Americas PLISA, based on a system of mandatory notification that covers all of the countries and territories. Currently, there are 46 countries and territories reporting, weekly and systematically, the number of dengue cases, incidence rate, number of severe cases, number of deaths and case fatality rate, as well as entomological surveillance data.
There is still a need to improve the quality of the data provided by the member countries and to incorporate new drivers such as clinical classification, manifestations, diagnostic tests used and viral serotypes behavior.

To achieve this protocol's goal integration is mandatory, although how this will be done is still open to definition: integration (information comes from the same source) or interface (a bridge that allows two programs to share information with each other, even when they have different sources of information). How to integrate the surveillance of chronic complications is also a concern.

Country experiences: Mexico

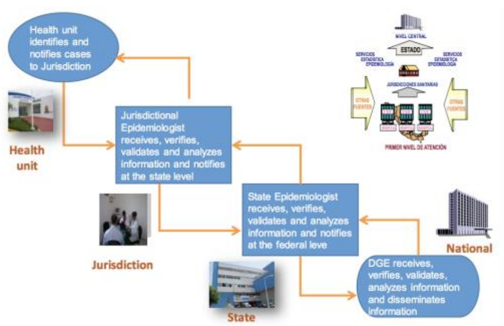
Challenges, obstacles and proposals for dengue and arbovirosis surveillance

Biól. José Cruz Rodríguez Martínez
Epidemiologia Secretarìa de Salud Mexico , Epi– centro de la Salud Pùblica

Mexico presents a complex scenario for surveillance. It is the fifth largest country in America (1,964 million km^2, and a population of over 123 million inhabitants). Of the 32 states in Mexico, 29 have viral transmission, accounting to 25,077 health units responsible of case detection and notification.

Figure 6 shows the dengue information flow in Mexico. The health unit identifies and notifies cases to the jurisdiction where the information is initially validated and afterwards reported at the state level, where a second validation takes place. The general directorate of epidemiology, after a third validation, finally communicates the information.

Figure 6. Dengue information flow in Mexico



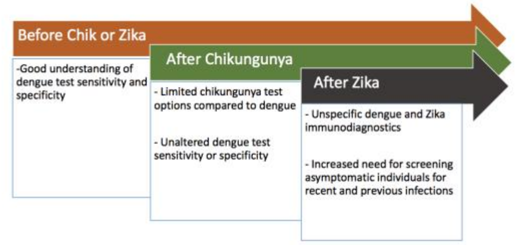
The ultimate goal of the epidemiological surveillance system for arboviral diseases is to produce quality epidemiological information to guide decision making. Decisions should be aimed at eliminating or mitigating health risks by timely identifying viral circulation, epidemiological characterization and by assessing risk factors to provide accurate information to guide prevention and control.

The challenges of Dengue and Zika diagnosis in areas of co-endemicity

Jorge L. Muñoz-Jordán, Ph.D.
Chief, Surveillance and Research Laboratory Centers for Disease Control and Prevention Division of Vector Borne Diseases San Juan, Puerto Rico

Zika, dengue and chikungunya are three similar diseases transmitted by the same mosquitoes. Of similar geographical distribution, they are present in approximately 100 countries, posing 2 billion people at risk of infection every year. Currently, there are no vaccines or therapeutics commercially available for zika, dengue and chikungunya. They have common and specific symptoms: febrile illness, rash, body aches are seen in the three diseases, while dengue causes hemorrhagic disease; chikungunya leads to severe arthritis and zika to Guillain Barre' syndrome and birth defects (Figure 7).

Figure 7. The changing landscape of arbovirus diagnoses



There is no doubt that a tool for the integrated diagnosis and care of dengue, chikungunya and zika is needed, particularly in light of the new challenges to be faced in diagnosis: the serological crossed-reaction with flavivirus and the large proportion of asymptomatic infections, which turn screening pregnant/reproductive aged women and potential dengue vaccines recipients a must.

The recent immunoassay developments show that dengue vs zika ratios increase specificity of IgM tests without reducing sensitivity; NS1 antibody detection tests are more specific than E antibody detection tests and there is a differential avidity of antibodies for dengue and zika E and NS1/NS5 antigens. Molecular testing becomes a standard goal due to the high sensitivity of PCR during acute illness: approximately 60-75% of cases can be diagnosed during the first 6 days of illness. The CDC-Trioplex RT-PCR assay detects dengue, chikungunya and zika viruses and has been adapted and validated for widely available equipment. Further tests should be developed to address both symptomatic and asymptomatic/post-symptomatic patients, while CDC-Trioplex RT-PCR assay is implemented in in endemic areas, monitoring and evaluating its performance and feasibility to apply in potential dengue vaccine programs.

Session 3
Integrated Management of Vector Control

Integrated Vector Management: A regional overview

Haroldo Bezerra
Regional Advisor Public Health Entomology PAHO/WHO

An integrated vector management (IVM) is an innovative approach to vector control, of central relevance to reduce the risk of transmission of vector borne diseases (VBD). The key elements of IVM are:

1. Advocacy, social mobilization and legislation.
2. Collaboration within the health sector and other sectors.
3. Integrated approach (nonchemical and chemical).
4. Evidence-based decision making.
5. Capacity building.

Currently, reducing the risk of spreading VBD requires strengthening international, intersectoral and interdisciplinary coordination, encompassing the efforts of the countries, PAHO, WHO and other partners to strengthen the integrated analysis of the entomological and epidemiological information for decision making.

A regional network to monitor and manage resistance to insecticides has developed a manual of procedures for the evaluation of resistance to insecticides used in public health. Participating countries are Argentina, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, French Guyana, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Dominican Republic, Suriname and Uruguay. Key components for the success of this joint regional effort is to train human resources and the community: expert groups to provide technical support as required by countries (entomology and vector control) as well as training in the rational use of insecticides and equipment for the application of insecticides.

The "Mosquito Awareness Week" is in practice since 2016.

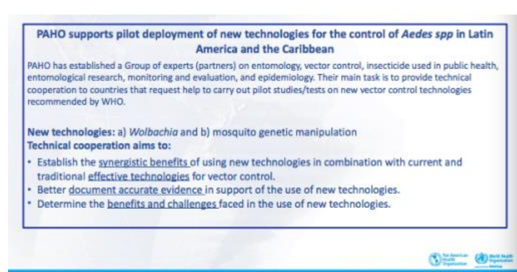
The Technical Advisory Group (TAG) has defined the priorities of PAHO/WHO Regional Program of Public Health Entomology and Vector Control: strengthening the practice of the entomology in Public Health; establishing a surveillance and management system for insecticide resistance and reviewing, updating and implementing IVM.

PAHO is also supporting pilot deployment of new technologies for the control of *Aedes spp* in Latin America and the Caribbean and has established a group of experts on entomology, vector control, insecticide used in public health, entomological research, monitoring and evaluation, and epidemiology. Their main task is to provide technical cooperation to countries that request help to carry out pilot studies/tests on new vector control technologies recommended by WHO, such as:

a) *Wolbachia*, planned sites in Brazil, Colombia, Mexico,
b) Mosquito genetic manipulation, sterile insect techniques (SIT), sites in Brazil, Cuba, Mexico
c) Mosquito disseminated pyriproxifen, site in brazil.

Technical cooperation aims to:

- Establishing the synergistic benefits_of new technologies used in combination with current and traditional effective technologies for vector control.
- Better documenting accurate evidence_in support of the use of new technologies.
- Determining the benefits and challenges faced in the use of new technologies.



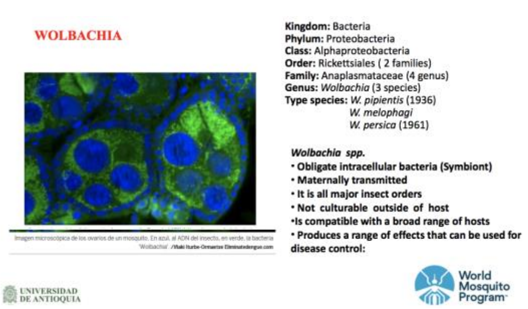
PAHO's document also states that the countries of the Americas will pledge to support this plan of action to reduce the burden and threat of VBD through effective, locally adapted, and sustainable vector control and best practices, including IVM in the period 2018-2023.

Advances on Wolbachia experience in Medellin, Colombia

Ivan Dario Velez, MD PhD
Universidad de Antioquia
Director PECET

Wolbachia is a safe and natural bacteria used to reduce the ability of mosquitoes to transmit viruses. A genus of Gram-negative bacteria that infects arthropod species, including a high proportion of insects, but also some nematodes. It is one of the world's most common parasitic microbes and possibly the most common reproductive parasite in the biosphere (Figure 8).

Figure 8. About Wolbachia



Wolbachia provides protection for dengue (4 serotypes), zika, chikungunya, yellow fever, West Nile and Mayaro viruses.

The bacteria is capable of blocking the vector's transmission of all these arboviruses. *Aedes spp.* infected with *Wolbachia* are less likely to acquire viral infection and those that get infected are not capable of transmitting the disease to humans. Figure 9 summarizes some of the most recent research with the bacteria.

Figure 8. Wolbachia: research

The World Mosquito Program (WMP) is a not-for-profit initiative that works to protect the global community from mosquito-borne diseases such as zika, dengue and chikungunya using *Wolbachia* to reduce the ability of mosquitoes to transmit these viruses.

The WMP has expanded rapidly since launching its first pilot study in Australia in 2011. Following promising results from international pilot studies, local governments and communities are embracing the WMP's *Wolbachia* method in 12 countries, with further projects in development.

Wolbachia is introduced into *Ae. aegypti* mosquitoes. Once *Wolbachia*-carrying mosquitoes are released, they breed with wild mosquitoes. Over time, the majority of mosquitoes carry *Wolbachia.* These mosquitoes have a reduced ability to transmit viruses to people, decreasing the risk of zika, dengue and chikungunya outbreaks (Figure 9).

Figure 9. World Mosquito Program strategy

Wolbachia can protect communities from mosquito-borne diseases, without posing risk to natural ecosystems or human health.

Dispersing stations of Pyriproxyfen

Sérgio Luz Bessa
FIOCRUZ/Amazônia,
Instituto Leônidas e Maria Deane

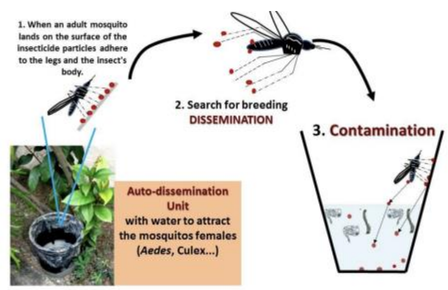
Pyriproxyfen (PPF) is a pyridine-based pesticide which is found to be effective against a variety of arthropoda. PPF is considered a juvenile hormone analog and an insect growth regulator. It prevents larvae from developing into adulthood and thus rendering them unable to reproduce.

The first trial using bloodfed females of *Ae. egypti* as a vehicle for the transfer of PPF was designed to answer the hypothesis if PPF would actually work at spatial scales relevant to vector control, particularly focusing on how far would mosquitoes carry PPF, what breeding-site coverage could be achieved, what effect it would have on juvenile mortality and on adult emergence. The key issue were the cryptic and inaccessible breeding sites and the difficulties for surveillance and control.

Researchers concluded that by expanding breeding-site coverage and boosting juvenile mosquito mortality, a strategy based on mosquito-disseminated PPF had a potential to substantially enhance mosquito control. Sharp declines in adult mosquito emergence can lower vector/host ratios, reducing the risk of disease outbreaks.

This approach is a very promising complement to current and novel mosquito control strategies; it will probably be especially relevant for the control of urban disease vectors, such as *Aedes* and *Culex* species, that often cause large epidemics.

Figure 10. Using adult mosquitoes to transfer insecticides



Session 4
Should we prepare for high impact dengue epidemics?

Potential Critical Dengue and Arbovirus Scenarios

Liliana Sánchez-González MD
MPH Epidemiology Team Dengue Branch, San Juan, PR

To predict potential arbovirus scenarios in Latin America and the Caribbean Region, historical data, current scenarios, scientific knowedge and modeling may be applied (…as well as a capacity to expect the unexpected).

Three scenarios are being considered:

1. Dengue epidemics with low levels of zika virus circulation
2. Zika epidemics with low levels of dengue virus circulation
3. Introduction of Yellow Fever

Preparedness for scenario one requires surveillance, focus on clinical management and rapid diagnostic testing. Scenario 2 calls for enhanced diagnostic testing of pregnant women, surveillance and follow-up testing for babies. To be ready for scenario 3 requires surveillance, early detection and clinical training. Yet, in all three scenarios, strengthening confirmatory diagnostic testing, including testing for other arboviruses, is mandatory. Vector control with all novel interventions, as well as vaccines, are essential tools in light of the future impact of arbovirus diseases.

Value of modeling in the dinamics of arbovirus transmission

Diana Patricia Rojas, MD PhD
University of Florida
Center Inference & Dynamics of Infectious Diseases

Mathematical and computational modeling approaches can be essential in providing quantitative scenarios of disease spreading, as well as in projecting the impact on the population. A model was designed to analyze the spatial and temporal dynamics of the zika virus epidemic in the Americas with a microsimulation approach informed by high-definition demographic, mobility, and epidemic data, providing probability distributions for the time and place of introduction of zika in Brazil, the estimate of the attack rate, timing of the epidemic in the affected countries, and the projected number of newborns from women infected by zika.

In the future, new models need to be developed and validated to explore several varied hypotheses, such as characterize historical and recent transmission of arbovirus analyzing the time-series data to estimate possible future transmission scenarios; to establish if the emergence of zika in Brazil might be related to recent changes in dengue dynamics (cross-protection and/or enhancement) and to test other hypothesis about the possible relationship of yellow fever vaccine coverage and zika severe outcomes.

Other applications of modeling on transmission dynamics of arbovirus could be to cluster randomized trials for new technologies for vector control with epidemiological measures such as *Wolbachia*, irradiated mosquitoes, dispersing stations of PPF and sterile mosquitoes to reduce the density of *Ae. aegypti.*

Conclusions and next steps

- The group of experts participating in this workshop agreed that countries should closely monitor the evolution of arbovirus epidemiology and develop plans for mitigation and controlling potential severe outbreaks.
- A workshop in 2019 was proposed to discuss the progress on arbovirus control, and the implementation of the Arbovirus Management strategy in the Region.
- FIU and PAHO will prepare a regional proposal on the key challenges, gaps and monitoring of the arbovirus integrated management system.
- The group proposed to include in the agenda of the next workshop in 2019:
    - Update on dengue and zika vaccines: development stage, recommendations, key issues and how to overcome them.
    - Session on risk/crisis management and communication
    - Discuss best practices on arboviruses control
    - Evaluate the progress on arbovirus integrated surveillance and data reporting.