MULTIPLEX BEAD ASSAY FOR INTEGRATED SEROLOGICAL SURVEILLANCE OF COMMUNICABLE DISEASES

IN THE REGION OF THE AMERICAS

Report of the third regional meeting (Cuernavaca, 4 and 5 March 2020)
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1. Background

In 2016, the Pan American Health Organization (PAHO) and the U.S. Centers for Disease Control and Prevention (CDC) initiated a strategic partnership to transfer multiplex bead assay (MBA) technology to countries across the Americas interested in implementing integrated serological surveillance of communicable diseases. The purpose of this partnership is to provide evidence and demonstrate the added value of the MBA platform for surveillance in different epidemiological scenarios, with a view to providing supplemental tools to make epidemiological surveillance more efficient, objective, and dynamic.

During stage one of this initiative, Colombia, Mexico, and Paraguay were invited to take part in a meeting held in Bogota (Colombia) to establish a roadmap for development of population-based surveys and review the technical and logistical aspects needed to implement the platform. The second meeting was held in Mexico City (Mexico) in July 2017. Delegates from Brazil, Mexico and Paraguay attended, following up on the process of strengthening the capacities of national public health laboratories to use the multiplex platform. In addition, the delegates reviewed the development and implementation of protocols for conducting integrated serological surveys.

The third meeting was held in Cuernavaca, Mexico, on 4-5 March 2020. A summary of this meeting is given in the present report. During the meeting, each of the participating countries’ progress on implementation of integrated serological surveillance was reviewed. In addition, lessons learned were shared, new opportunities were identified, and recommendations were made to expand the use of this tool in the Region. Peru also joined the initiative as a new candidate.

It bears stressing that the proposed recommendations and actions will be affected by the social distancing and containment measures implemented following the declaration of a pandemic of SARS-CoV-2 infection (COVID-19) by the World Health Organization (WHO) on 11 March 2020. PAHO will coordinate with countries and partners across the Region to find the most appropriate and feasible mechanisms for progressing along the roadmap proposed in this document.
2. Purpose and results of the meeting

The purpose of the meeting was to review progress in the implementation of the multiplex platform, identify lessons learned and opportunities for continuous improvement, and expand the use of integrated serological surveillance of communicable diseases in the Region of the Americas.

Expected outcomes of the meeting included:

- Understanding the challenges and opportunities of using multiplex-based integrated serological surveillance as part of communicable disease surveillance systems in the countries of the Region.

- Prepare a preliminary list of opportunities to strengthen integrated serological surveillance in countries whose laboratories already have multiplex platform capacity.

- Prepare a preliminary list of opportunities to expand integrated serological surveillance in the Region of the Americas.

A detailed agenda of the meeting is given in Appendix 1.
3. Participants

- Delegates from the ministries of health of Brazil, Mexico, Paraguay, and Peru, the latter as a potential candidate for implementation of the initiative.

- Delegates from the CDC, the Mundo Sano Foundation, and the Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET), the latter representing the Task Force for Global Health (TFGH).

- PAHO/WHO delegates: advisors on immunization and communicable diseases from the PAHO/WHO offices in the invited countries, as well as representatives of the Neglected, Tropical and Vector-Borne Diseases Unit and the Comprehensive Family Immunization Unit.

A detailed list of participants is given in Appendix 2.
4. Stage one of the initiative: progress and lessons learned

After reviewing each country’s progress and discussing key challenges, lessons learned, and opportunities with all participants, the following relevant issues were identified.

4.1. Progress of individual countries participating in the initiative

The three participating countries are at different stages in the process of developing and implementing integrated serological surveys to characterize the immunity profiles of selected population groups against the communicable diseases identified as priorities in each country. Appendix 3 describes the characteristics of each country’s surveys. The most relevant aspects of progress in each of them are summarized below:

- Brazil is developing a protocol that is still under review. Banked serum samples collected for a dengue survey conducted in urban areas of the country between 2015 and 2017 will be used.
• **Mexico** developed a pilot project to determine the usefulness of incorporating the multiplex platform as a tool in its communicable disease surveillance system. The project was based on a cross-sectional, descriptive study of 1,012 schoolchildren (age 3-15 years) enrolled in the public basic education system (preschool, primary, and secondary). Their caregivers (220 adults, age 18-30 years) were also included, using a convenience sampling strategy. Recruitment took place in six municipalities in the states of Chiapas, Morelos, and Sinaloa. The sample size was smaller than expected due to difficulties in obtaining informed consent from the participants. A total of 11 antigens were tested for a survey of malaria, trachoma, taeniasis/cysticercosis, measles, rubella, and diphtheria. Multiplex technology was successfully transferred to the Institute of Epidemiological Diagnosis and Reference Dr. Manuel Benítez Báez (InDRE), which analyzed the samples collected during the aforementioned survey. A database with the results was then compiled and the preliminary descriptive analyses, which were presented at the meeting, were completed with support from the interprogrammatic group established in Mexico to steer development of the survey, and from PAHO/WHO and the CDC.

• **Paraguay** conducted a survey of children enrolled in public schools in the Chaco Paraguayo region. A representative sample of 1,200 children (age 6-15 years) was selected, and 14 antigens were tested, for trachoma, taeniasis/cysticercosis, strongyloidiasis, giardiasis, cryptosporidiosis, toxoplasmosis, measles, rubella, diphtheria, and tetanus. Fieldwork was protracted due to flooding and difficulties in accessing study areas. Nevertheless, a total of 1,104 samples were collected. Multiplex technology was transferred to the Central Public Health Laboratory and sample processing was completed by the end of February 2020. The country is working on cleaning and verifying the database to proceed with descriptive analysis and discussion of the results. This is expected to be completed in the second half of 2020.

The use of multiplex serology for communicable disease surveillance has expanded to countries which, in the period 2018–2019, conducted surveys to assess the situation of certain neglected infectious diseases. **Guatemala**, for instance, conducted a nationwide survey to estimate the prevalence of soil-transmitted helminth infections in children enrolled in public schools, which included a 20-antigen serology panel. **Guyana** implemented a survey of school-age children in six regions of the country to determine the level of lymphatic filariasis transmission, and included serology for 18 antigens. Samples from these two countries will be processed at the CDC, as they do not yet have capacity in place to use the multiplex platform in their national laboratories.
4.2. Lessons learned

Important lessons have been gleaned from the countries’ experience during stage one of the integrated serological surveillance initiative, including:

1. **It is essential to ensure implementation of robust surveys that yield results representative of the study population.** The epidemiological scenario-based approach facilitates the selection of priority geographic areas, diseases, and antigens. In addition, proper operationalization of variables is critical to defining and validating the questions included in the questionnaires and collecting the data needed to generate indicators and results that will be useful to support decision-making. The timeliness and quality of data collection can be improved with the aid of electronic devices.

2. **Interprogrammatic work is key.** The survey coordination team should be clearly defined and involved from the planning and protocol development stage through to implementation of field operations and analysis of the results of integrated serological surveillance. The team should include program managers, statisticians, epidemiologists, and experts in each of the diseases selected for surveillance, as well as other professionals as appropriate, so as to ensure availability of the knowledge, skills, and capacities necessary to generate, interpret, and use data to support decision-making.

3. **Coordination and involvement of local sectoral and cross-sectoral actors must be ensured during all phases of the survey development process.** For example, if the survey is to be conducted in schools, it is essential to establish a relationship between the Ministry of Education and subnational departments of education from the outset. It is necessary to involve and coordinate closely with the educational community (principals, teachers, parents/caregivers, etc.) to ensure that processes run smoothly and promote adherence to the methods established in the protocol. In the case of household surveys, a similar degree of coordination should be established with community leaders, as their participation is essential to ensure that processes run smoothly and are aligned.

4. **Plans for the implementation of surveys for integrated serological surveillance need to be adjusted to anticipate and respond in a timely manner to unforeseen events,** such as emergencies and natural disasters, disease outbreaks, civil unrest and insecurity, or language barriers, among others, which might disrupt the survey schedule. The interprogrammatic group should monitor the survey schedule and fieldwork to make the necessary adjustments and ensure the safety of teams and participants, and to take the necessary action to achieve the expected objectives.
5. **Data analysis requires pooling information from various sources.** In addition, data triangulation techniques should be applied to explain and interpret the results of integrated serological surveillance of communicable diseases. Disaggregated epidemiological data from study groups and areas and program performance information must be collected and made available, not only to inform the proposed methodology but because these data will be used during analysis and interpretation of the results. For example, in the case of vaccine-preventable diseases (VPDs), serology data on the chosen antigens should be interpreted taking into account historical information on vaccination strategies and coverage of the population cohorts under study, epidemiological monitoring of VPDs, and the quality of the cold chain, among other variables. The analysis should also consider the limitations of the design and methodology of the survey, as well as the laboratory platform used (in this case, the multiplex platform). For example, the sensitivity and specificity of each antigen and the possibility of cross-reactions, among others, should be taken into account.

6. **There was a successful transfer of CDC capacities to participating laboratories in Mexico and Paraguay for the use of the multiplex platform.** The two countries currently have the capacities and technology to analyze samples using this assay method. The appropriate profile and expertise of the technicians involved in cross-country capacity transfer was key to success. Some aspects that still need to be strengthened involve standardization, identification and problem solving at all stages of sample processing and analysis, and internal and external quality control processes.

7. **The use of banked serum samples and existing databases provides an opportunity to conduct retrospective integrated serological surveillance.** Such studies require proper design and research questions that are formulated so that they can be answered with samples from the selected source. Expert support and liaison is important in countries that are interested in using serum banks for serological surveillance. However, it is essential to recognize the limitations of such studies and to employ data triangulation methodologies to generate useful information for decision-making.

8. **To make more efficient use of resources and expand integrated serological surveillance of communicable diseases,** it is essential that efforts be articulated with the teams in charge of conducting periodic surveys. These include demographic, reproductive-health, nutrition, multiple-indicator cluster surveys, or scheduled surveys for the elimination of other diseases (such as neglected infectious diseases and malaria). The use of expanded informed consent, wherein participants authorize the storage and custody of samples and clinical and demographic information, facilitates future serological analysis of diseases relevant to public health.
5. **Stage two of the initiative:** recommendations to advance and expand integrated serological surveillance

The main recommendations proposed to expand integrated serological surveillance in the Region of the Americas are:

**Countries that participated in stage one of the initiative should conclude analysis of their data and dissemination of their survey results.** They will then move on to stage two, in which they will develop surveys of their own with robust designs that allow results to be inferred in study populations.

**During stage two of the initiative, participating countries should incorporate the lessons learned and recommendations from the first stage into their protocol development.** This requires review and adjustment of national interprogrammatic groups; a clearly established need for an integrated serological survey; agreement on which research questions should be answered in each epidemiological scenario; selection of sample design, type of study, and most appropriate population to answer the research questions; and proper definition and operationalization of the variables needed to develop the questionnaires, among other aspects. It is highly recommended that electronic devices be used for data collection, and that data collection instruments include expanded informed consent to facilitate the use of samples in future studies.

**Epidemiological scenarios should serve as a guide for the design of integrated serological surveys.** Countries are advised to continue using epidemiological scenarios to determine the need for surveys and to develop research questions. These scenarios are not restrictive, so countries can identify and propose other relevant scenarios for integrated serological surveillance. PAHO is advised to include a scenario related to operational research to which countries can contribute useful information, i.e., by contributing to antigen validation and characterization and to their use on the multiplex platform.
Progress should be made on standardizing the necessary procedures for countries to use serology as a supplemental tool for communicable disease surveillance. Guidelines and manuals are needed to support protocol development and implementation of integrated serological surveys, as are documents on laboratory procedures. A good practices handbook for integrated serological surveys is currently under review, and is expected to contribute to the process of standardizing concepts and procedures.

Promote collaborative work among national public health laboratories participating in the initiative. This will allow countries to share lessons learned and move forward together to create standard laboratory operating procedures, troubleshooting guidelines, internal and external quality control programs, and laboratory performance assessment programs, among others, with support and coordination from CDC and PAHO.

Identify the capacity-building and refresher training needs of national teams participating in the initiative. This includes technicians and other staff at national public health laboratories. In addition, the necessary mechanisms should be put in place to consolidate capacities and strengthen skills over time, such as the development of training manuals and materials.

Strengthen capacities for data analysis and the interpretation of the results of integrated serological surveys in participating countries. PAHO, with the support of CDC, is advised to promote strengthening of data analysis capabilities for decision-making through the development of tools, educational materials, and training.

Promote and establish partnerships to optimize the use of resources to implement integrated serological surveys in each country. This includes incorporating the serology component into periodic or prospectively scheduled surveys for communicable diseases, as well as the use of banked serum for retrospective studies. This requires coordination and leadership from ministries of health, establishing communication channels and partnerships to facilitate this cooperation.

Partnerships with various initiatives and working groups are recommended as a means of articulating and joining efforts to expand integrated serological surveillance. This includes national health institutes, experts, academia, research centers, and WHO collaborating centers, among others. One example is field epidemiology training programs, which would facilitate the involvement of the existing workforce (trained staff and program tutors) in the development and implementation of serological surveys in countries with such in-service training programs. In particular,
a panel of experts should be convened to support implementation of a work plan to make antigens available for the serological study of priority conditions such as Chagas disease.

Support domestic advocacy efforts to help Peru formally participate in the initiative and begin the process of launching its first integrated serological survey. During this process, the country will need support from the CDC and PAHO, and will need to leverage the lessons learned during stage one to carry out a robust survey and complete the transfer of capacities to the national laboratory.

Publish lessons learned during stage one of the initiative to facilitate implementation and provide evidence on the experience of incorporating this tool into epidemiological surveillance systems for communicable diseases. Such a publication should also prove useful for countries using the tool for the first time and encountering similar difficulties.
6. Tasks to be carried out within one year

Mexico and Paraguay, which conducted surveys during stage one of the initiative, will complete a data analysis to prepare the report, disseminate the results, and share the lessons learned during stage one.

The Best Practices Manual for Conducting Integrated Serological Surveys will be reviewed and modified as needed; the English version will be revised by the CDC. A meeting will be scheduled to reach a consensus on changes, incorporate the agreed changes, and produce a consensus version revised by the countries, CDC, and PAHO.

A workshop will then be scheduled to train delegates from the participating countries and strengthen their capacities for data analysis, visualization, and interpretation of results from integrated serological surveys.

Another meeting will be held with delegates from the national public health laboratories of participating countries. Lessons learned will be shared and guidelines will be developed for troubleshooting, internal and external quality control procedures, and external performance evaluation, among others.

Brazil, Mexico, and Paraguay will review the roadmap for implementation of stage two of the initiative—proposed at this meeting (Appendix 4)—and share it with their teams. In the specific case of Peru, the roadmap has been designed to facilitate domestic advocacy that will enable it to confirm its interest in taking part in the initiative. PAHO will officially inform the four countries of the initiative and the offer of support and technical cooperation, and will ask them to reply with an official statement of interest in participating. Once its interest is confirmed, each country will set up a national interprogrammatic team, propose research questions for integrated serological surveillance in its epidemiological scenario or scenarios of interest, devise an integrated protocol, and work on strengthening laboratory capacities for use of the multiplex assay platform.
7. Medium- and long-term opportunities

The participants identified the following opportunities for the use of integrated serological surveillance, with a view to advancing development of the platform:

1. The Integrated, Sustainable Framework to Elimination of Communicable Diseases in the Americas, approved by PAHO Member States in 2019 (document CD57/7 and Resolution CD57.R7), provides opportunities for the use and expansion of integrated serological surveillance.

2. The first and second stages of the initiative in the Region focused on the development and implementation of population-based surveys. However, this tool could also be used for other modes of surveillance, such as outbreak investigation, sentinel surveillance, multicenter surveillance, and operational research, among others.

3. Opportunities for the use of integrated serological surveillance were identified, such as monitoring of zoonotic diseases of public health interest. Mexico expressed its interest in using the multiplex platform for post-elimination surveillance of human dog-mediated rabies, as the first country in the world to achieve this goal. This requires coordination and the establishment of working groups with stakeholders and partners in the veterinary public health sector. It would also provide an excellent opportunity and incentive to monitor animals and humans for various zoonotic diseases.

4. It is both necessary and expected that there will be opportunities for joint work between countries, PAHO, and CDC to advance the validation, characterization, and availability of antigens for serological surveillance of priority public health diseases of interest in the Region and to incorporate them into the multiplex platform. These may include antigens for arboviral illnesses (dengue, yellow fever, Zika, chikungunya, etc.), Chagas disease, leishmaniasis, and Hansen’s disease. Other antigens include those used in malaria surveillance, especially additional antigens for *Plasmodium vivax*, and potential markers such as histidine-rich protein 2, which allows detection of deletion mutations and helps guide selection of rapid diagnostic tests for *falciparum* malaria, human papillomavirus, and pertussis, among others.

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5. Appropriate schemes must be identified to provide countries with beads coupled to antigens of interest for integrated serological surveillance. Alternatives must ensure both high quality and affordable cost. Options that should be explored include the transfer of capacities to one or two countries in the Region which could then manufacture specific bead panels, or commercial production by an established manufacturer.

6. Outcome indicators for the multiplex initiative must be defined and measured over time in order to monitor the progress made by participating countries toward strengthening their communicable disease surveillance systems through integrated serological surveys.
8. **References**


Appendixes
Appendix 1.
List of Participants

Delegates of international organization and partners

**Maria Florencia Casale**
Department of Programs and Projects
Mundo Sano Foundation
Calle Paraguay 1535, C1061ABC
Ciudad de Buenos Aires, Argentina
Tel: +54 (11) 4872-1333
Email: mfcasale@mundosano.org

**Diana L. Martin**
Division of Parasitic Diseases and Malaria
U.S. Centers for Disease Control and Prevention (CDC)
1600 Clifton Road, NE, MS A-06
Atlanta, GA 30333
Tel: +1 (404) 718-4147
Email: hzx3@cdc.gov

**Gretchen Cooley (joined via WebEx)**
Division of Parasitic Diseases and Malaria
U.S. Centers for Disease Control and Prevention (CDC)
1600 Clifton Road, NE, MS A-06
Atlanta, GA 30333
Tel: +1 (404) 718-4132
Email: xxd1@cdc.gov

**Eric Rogier (joined via WebEx)**
Division of Parasitic Diseases and Malaria
U.S. Centers for Disease Control and Prevention (CDC)
1600 Clifton Road, NE, MS A-06
Atlanta, GA 30333
Tel: +1 (404) 718-4414
Email: wwx6@cdc.gov

**Melissa Coughlin**
Division of Viral Diseases
U.S. Centers for Disease Control and Prevention (CDC)
1600 Clifton Road, NE, MS A-06
Atlanta, GA 30333
Tel: +1 (404) 639-1351
Email: mcoughlin@cdc.gov

**Heather Scobie (joined via WebEx)**
Global Immunization Division (GID)
U.S. Centers for Disease Control and Prevention (CDC)
1600 Clifton Road, NE, MS H24-3
Atlanta, GA 30329-4027
Tel: +1 (404) 718-4543
Email: vih8@cdc.gov

**Benjamin Dahl**
Global Immunization Division (GID)
U.S. Centers for Disease Control and Prevention (CDC)
1600 Clifton Road, NE, MS A-06
Atlanta, GA 30333
Tel: +1 (404) 639-0972
Email: bid5@cdc.gov

**Annemarie Wasley (joined via WebEx)**
Global Immunization Division (GID)
U.S. Centers for Disease Control and Prevention (CDC)
1600 Clifton Road, NE, MS H24-3
Atlanta, GA 30329-4027
Tel: +1 (404) 498-1108
Email: acw5@cdc.gov

**Angela Hilmers**
Training Programs in Epidemiology and Public Health Interventions Network (TEPHINET)
325 Swanton Way
Decatur, GA 30030
Tel: +1 (470) 289-0257
Email: ahilmers@tephinet.org

**Ryan E. Wiegand (joined via WebEx)**
Division of Parasitic Diseases and Malaria
U.S. Centers for Disease Control and Prevention (CDC)
1600 Clifton Road, NE, MS A-06
Atlanta, GA 30333
Tel: +1 (404) 639-2031
Email: fwk2@cdc.gov
Country delegates

Brazil

Luis Gustavo Morello
Coordinator, In Vitro Diagnostics, Instituto de Biologia Molecular do Paraná (IBMP)
Head, Laboratory of Applied Health Sciences and Technologies, Instituto Carlos Chagas, FIOCRUZ
Rua Prof. Algacyr Munhoz Mader, 3775
CIC, Curitiba/PR (Brazil)
Tel: +55 (41) 3316-3260
Email: lgmorello@ibmp.org.br

Jesus Martinez Barnetche
Assistant Director-General
Center for Investigation of Infectious Diseases (CISEI)
National Public Health Institute (Mexico)
Av. Universidad 655, Santa María Ahuacatitlán
Cuernavaca (Mexico)
Tel: 777 112 1223
Email: jmbar@insp.mx

Mexico

Celia Alpuche Aranda
Assistant Director-General
Center for Investigation of Infectious Diseases (CISEI)
National Public Health Institute
Av. Universidad 655 Colonia Santa María Ahuacatitlán, Cerrada Los Pinos y Caminera C.P. 62100
Cuernavaca (Mexico)
Email: celia.alpuche@insp.mx

Guillermo Carbajal Sandoval
Head, Department of Epidemiological Surveillance of Vector-Borne Diseases
Secretariat of Health (Mexico)
Francisco de P. Miranda 177, Lomas de Plateros, Álvaro Obregón, 01480 Ciudad de México (Mexico)
Tel: +52 (55) 5337-1755
Email: guillermo.carbajal@salud.gob.mx

Jesus Martinez Barnetche
Center for Investigation of Infectious Diseases (CISEI)
National Public Health Institute (Mexico)
Av. Universidad 655, Santa María Ahuacatitlán
Cuernavaca (Mexico)
Tel: 777 112 1223
Email: jmbar@insp.mx

Miguel Sánchez Alemán
Center for Investigation of Infectious Diseases (CISEI)
National Public Health Institute (Mexico)
Av. Universidad 655, Santa María Ahuacatitlán
Cuernavaca (Mexico)
Email: msanchez@insp.mx

Verónica Gutierrez Cedillo
Deputy Director for Rabies and other Zoonoses
National Center for Prevention Programs and Disease Control (CENAPRECE)
Calle Benjamín Franklin 132, colonia Escandón 11800, Ciudad de México (Mexico)
Tel: +52 (55) 639287438
Email: veronica.gutierrez@salud.gob.mx

Gustavo Sánchez Tejeda
Director, Vector Department
National Center for Prevention Programs and Disease Control (CENAPRECE)
Cto. Interior Mtro. José Vasconcelos 221, San Miguel Chapultepec II Secc, Miguel Hidalgo, 11850, Ciudad de México (Mexico)
Tel: +52 (55) 5128-0000
Email: gustavo.sanchez@salud.gob.mx

Belem Torres Longoria
Project Coordinator
Directorate for Diagnosis and Referral
Institute of Epidemiological Diagnosis and Reference (InDRE)
Secretariat of Health (Mexico)
Francisco de P. Miranda 177, Lomas de Plateros, Álvaro Obregón, 01480 Ciudad de México (Mexico)
Tel: +52 (55) 5062.1600
Email: belem.torres@salud.gob.mx
Federico Alonso Zumaya Estrada  
Center for Investigation of Infectious Diseases (CISEI)  
National Public Health Institute (Mexico)  
Av. Universidad 655, Santa María Ahuacatitlán  
Cuernavaca (Mexico)  
Tel: 777 344 1466  
federico.zumaya@insp.mx

Claudia Huber Schill  
Central Public Health Laboratory (Paraguay)  
Av. Venezuela y Tte. Escurra  
Asunción (Paraguay)  
Tel: +595 (981) 965995  
Email: clauhs57@gmail.com

César Omar Zúñiga Ocampo  
Medical Supervisor, Regulatory Area  
National Center for Child and Adolescent Health (CENSIA)  
Secretariat of Health (Mexico)  
Francisco de P. Miranda 177, Lomas de Plateros, Álvaro Obregón,  
01480 Ciudad de México (Mexico)  
Tel: +52 (55) 5062-1600 ext. 41132  
Email: cesar.zuniga@salud.gob.mx

Peru

Nestor Edwin Cabezudo Pillpe  
Ministry of Health (Peru)  
National Health Institute (INS)  
Capac Yupanqui No. 1400  
Jesus Maria, Lima 11  
Tel. +511 748-1111 ext. 2180  
Email: ecabezudo@ins.gob.pe

Paraguay

Patricia Galeano  
Directorate of Communicable Disease Surveillance  
Ministry of Health (Paraguay)  
Brasil entre Fulgencio R Moreno y Manuel Domínguez  
Asunción (Paraguay)  
Tel. +595 (971) 501072  
Email: patygalfer@hotmail.com

Pan American Health Organization

María de la Paz Ade y Torrent  
Advisor, Malaria Diagnostics and Supply Management  
Communicable Diseases and Environmental Determinants of Health (CDE)  
PAHO/WHO Headquarters (WDC)  
525 23rd St. NW  
Washington, D.C. 20037  
Tel: +1 (202) 974-3271  
Email: ademarap@paho.org

Emilia Cain  
Focal Point for Immunization  
PAHO/WHO Mexico  
Montes Urales 440, Piso 2  
Colonia Lomas de Chapultepec  
11000 Ciudad de México (Mexico)  
Tel: +52 55 5980-0862  
Email: caine@paho.org

Luis Gerardo Castellanos  
Head, Neglected, Tropical and Vector-Borne Diseases Unit  
Communicable Diseases and Environmental Determinants of Health (CDE)  
PAHO/WHO Headquarters (WDC)  
525 23rd St. NW  
Washington, D.C. 20037  
Tel: +1 (202) 974-3191  
Email: castellanosl@paho.org

Daniel Guerrero Torres  
Administrative Assistant  
PAHO/WHO Mexico  
Montes Urales 440, Piso 2  
Colonia Lomas de Chapultepec  
11000 Ciudad de México (Mexico)  
Tel: +52 55 5980-0862  
Email: guerrerdan@paho.org
Multiplex Bead Assay for integrated serological surveillance of communicable diseases in the Region of the Americas

Fabiana Paola Michel Valdez
Advisor, Immunization
PAHO/WHO Paraguay
Edificio “Faro del Río”, Mcal. López 957
Esq. Estados Unidos 55555
Asunción (Paraguay)
Tel: +51 1.319.5774
Email: michelf@paho.org

Raul Montesano Castellanos
Advisor, Immunization
PAHO/WHO Peru
Los Pinos 251 Urb. Camacho
Lima 12 (Peru)
Tel. +511 319-5782
Email: montesanora@paho.org

Ana Morice
International Consultant, PAHO Headquarters
San José, Escazú (Costa Rica)
Tel. +011 (506) 8811-7568
Email: moriceana@paho.org

Gloria Janneth Rey
Advisor, Laboratory Network Management
Comprehensive Family Immunization
PAHO/WHO Headquarters (WDC)
535 23rd St. NW
Washington, D.C. 20037
Tel: +1 (202) 974-3217
Email: reyglori@paho.org

Claudia Romo
External International Consultant
Huiramba, Michoacán (Mexico)
Tel: +52 434.105.4626
Email: claudiasromo@gmail.com

Martha Saboyá
Advisor, Neglected Infectious Diseases Epidemiology
Communicable Diseases and Environmental Determinants of Health (CDE)
PAHO Headquarters
525 23rd St. NW
Washington, D.C. 20037
Tel: +1 (202) 974-3875
Email: saboyama@paho.org

Maria Jesús Sánchez
Advisor, Health Surveillance, Disease Prevention and Control (HSD)
PAHO/WHO Mexico
Montes Urales 440, Piso 2
Colonia Lomas de Chapultepec
11000 Ciudad de México (Mexico)
Tel: +52 55.5980-0880
Email: sanchezmarWpaho.org
## Appendix 2.
### Meeting agenda

**Wednesday, 4 March 2020**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker or facilitator</th>
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<tbody>
<tr>
<td><strong>Opening session</strong></td>
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<tr>
<td>9:00-9:30 a.m.</td>
<td><em>Welcome address</em>&lt;br&gt;PAHO/WHO Mexico&lt;br&gt;Delegate of Mexican Secretariat of Health&lt;br&gt;Delegate of National Public Health Institute (Mexico)&lt;br&gt;Unit Chief, PAHO/WHO Neglected, Tropical and Vector Borne Diseases Unit</td>
<td><strong>Maria Jesús Sánchez</strong>&lt;br&gt;Mexico Health Section&lt;br&gt;INSP Mexico&lt;br&gt;&lt;strong&gt;Luis Gerardo Castellanos**&lt;br&gt;Mexico Health Section&lt;br&gt;INSP Mexico&lt;br&gt;Unit Chief, PAHO/WHO Neglected, Tropical and Vector Borne Diseases Unit</td>
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<td>9:30-10:00 a.m.</td>
<td>Objectives and agenda</td>
<td><strong>Martha Saboyá, PAHO</strong></td>
</tr>
<tr>
<td>10:00-10:35 a.m.</td>
<td>Elimination Initiative: Opportunities to Expand the Use of Integrated Serological Surveillance&lt;br&gt;20-minute presentation&lt;br&gt;10-minute discussion</td>
<td><strong>Luis Gerardo Castellanos, PAHO</strong></td>
</tr>
<tr>
<td>10:00-10:35 a.m.</td>
<td>Integrated serological surveillance of population immunity and disease transmission: background and regional initiative&lt;br&gt;25-minute presentation&lt;br&gt;10-minute discussion</td>
<td><strong>Martha Saboyá, PAHO</strong></td>
</tr>
</tbody>
</table>

**Session 1. Progress and lessons learned from implementation of surveys on MBA-based integrated serological surveillance**

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker or facilitator</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:35-11:00 a.m.</td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>11:00-11:45 a.m.</td>
<td>Mexico: Survey results&lt;br&gt;25-minute presentation&lt;br&gt;20-minute discussion</td>
<td><strong>Delegate of Mexico</strong></td>
</tr>
<tr>
<td>11:45 a.m.-12:15 p.m.</td>
<td>Paraguay: Progress made in implementation of the survey&lt;br&gt;20-minute presentation&lt;br&gt;20-minute discussion</td>
<td><strong>Delegate of Paraguay</strong></td>
</tr>
<tr>
<td>12:15-1:00 p.m.</td>
<td>Brazil: Advances in protocol design&lt;br&gt;20-minute presentation&lt;br&gt;25-minute discussion</td>
<td><strong>Delegate of Brazil</strong></td>
</tr>
<tr>
<td>1:00-2:00 p.m.</td>
<td>Lunch Break</td>
<td></td>
</tr>
<tr>
<td>2:00-3:00 p.m.</td>
<td>Key lessons learned from the experience of Brazil, Mexico, and Paraguay (from protocols through fieldwork to use of results)</td>
<td>Plenary session led by Martha Saboyá (PAHO)</td>
</tr>
<tr>
<td>3:00-3:45 p.m.</td>
<td>Experience in other countries: Guyana and Guatemala&lt;br&gt;10-minute presentation (each)&lt;br&gt;25-minute discussion Can we expand this experience in 2020?</td>
<td><strong>Ana Morice and Claudia Romo, PAHO external consultants</strong></td>
</tr>
<tr>
<td>3:45-4:00 p.m.</td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>4:00-5:00 p.m.</td>
<td>What is our vision for the use of integrated serological surveillance in the Region of the Americas? Cost, technical and laboratory support, networking, bead coupling, horizontal cooperation, expansion, and other aspects</td>
<td>Plenary session led by Luis Gerardo Castellanos (PAHO)</td>
</tr>
</tbody>
</table>
## Thursday, 5 March 2020

<table>
<thead>
<tr>
<th>Time</th>
<th>Topic</th>
<th>Speaker or facilitator</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30-9:00 a.m.</td>
<td>Draft version of a best-practice manual for the implementation of surveys on integrated serological surveillance: progress</td>
<td>Martha Saboyá, PAHO</td>
</tr>
</tbody>
</table>
| 9:00-10:00 a.m. | Development of robust MBA-based surveys for integrated serological surveillance in Brazil, Mexico, and Paraguay: key aspects to consider:  
• Diseases to include  
• Epidemiological scenarios  
• Population groups  
• Protocol design  
• Information analysis and exchange | Plenary session led by Gloria Rey (PAHO)                      |
| 10:00-10:30 a.m.| Group work: Each country works on components to carry out stronger integrated serological surveys based on their discussion of the previous session |                                                             |
| 10:30-11:00 a.m.| Break                                                                |                                                             |
| 11:00-11:45 a.m.| Group work (cont’d.)                                                 |                                                             |
| 11:45 a.m.-12:30 p.m. | Presentation: results of group work activity and recommendations for each country | Plenary session led by Martha Saboyá (PAHO)                  |
| 12:30-1:30 p.m. | Lunch Break                                                          |                                                             |
| 1:30-2:30 p.m.  | How can we improve capacity to analyze and interpret the results of integrated serological surveillance? | Plenary session led by Martha Saboyá (PAHO)                  |
| 2:30-3:30 p.m.  | How can we expand the use of integrated serological surveillance within countries with transferred capacities? Main aspects to consider (ownership, leadership, sustainability) | Plenary session led by Luis Gerardo Castellanos (PAHO)       |
| 3:30-4:30 p.m.  | Creating a regional network of integrated serological surveillance laboratories | Plenary session led by Gloria Rey (PAHO)                     |
| 4:30-5:00 p.m.  | Reflections                                                           |                                                             |
### Appendix 3.
Profile of serological surveys already implemented in participating countries

<table>
<thead>
<tr>
<th>Feature</th>
<th>Multiplex initiative countries</th>
<th>Countries which have incorporated multiplex assays into existing surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mexico</td>
<td>Paraguay</td>
</tr>
<tr>
<td>Sample design</td>
<td>Survey of selected schools, two-stage cluster sampling</td>
<td>Survey of selected schools, two-stage cluster sampling</td>
</tr>
<tr>
<td></td>
<td>1,012 randomly selected children (age 3-15 years) and 220 adults (age 18-30 years) selected by convenience sampling</td>
<td>1,200 children (age 6-15 years) selected randomly in schools</td>
</tr>
<tr>
<td>Study population and sample size</td>
<td>Six municipalities across three states (Chiapas, Morelos, and Sinaloa), selected by convenience</td>
<td>Chaco Paraguayo region (departments of Alto Paraguay, Boquerón and Presidente Hayes)</td>
</tr>
<tr>
<td>Geographical areas</td>
<td>Nationwide</td>
<td>Nationwide</td>
</tr>
<tr>
<td>Antigens included in the survey</td>
<td>11 antigens for malaria, trachoma, taeniasis/cysticercosis, measles, rubella, and diphtheria</td>
<td>14 antigens for trachoma, taeniasis/cysticercosis, strongylidiasis, giardiasis, cryptosporidiosis, toxoplasmosis, measles, rubella, diphtheria, and tetanus</td>
</tr>
<tr>
<td></td>
<td>To be defined</td>
<td>20 antigens for malaria, onchocerciasis, strongylidiasis, trachoma, giardiasis, taeniasis/cysticercosis, measles, rubella, diphtheria, and tetanus</td>
</tr>
<tr>
<td>Progress status (as of March 2020)</td>
<td>Data analysis</td>
<td>Database cleaning in progress</td>
</tr>
<tr>
<td></td>
<td>Protocol design review and adjustments</td>
<td>Samples at CDC waiting to be processed</td>
</tr>
<tr>
<td>Next steps</td>
<td>Conclude data analysis and prepare report</td>
<td>Data analysis and preparation of report</td>
</tr>
<tr>
<td></td>
<td>Review and resubmit proposed protocol</td>
<td>Receive results from CDC; Data analysis and preparation of report</td>
</tr>
</tbody>
</table>
## Appendix 4.
### Country roadmap for stage two of the initiative

<table>
<thead>
<tr>
<th>Components</th>
<th>Countries</th>
<th>Date*</th>
<th>Activities</th>
<th>Date*</th>
<th>Activities</th>
<th>Date*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analyze the need, rationality, and feasibility of conducting a population-based survey for serological surveillance of communicable diseases at stage two</td>
<td>Mexico</td>
<td>May 2020</td>
<td>Consult program managers about their needs</td>
<td></td>
<td>Meeting to start the analysis of results, with support from PAHO and CDC</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Identify already scheduled surveys to facilitate joint work.</td>
<td></td>
<td>Workshop: presentation of results</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Analyze the feasibility of using banked serum samples.</td>
<td></td>
<td>Begin process of identifying needs, rationality, and feasibility of implementing a survey based on epidemiological scenarios.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>PAHO will send an official communication to Mexico regarding the formal start of stage two.</td>
<td></td>
<td>Map out surveys the country already conducts (school health, oral health, etc.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paraguay</td>
<td>April–June 2020</td>
<td>Review the protocol to determine whether the proposed sample design is appropriate for stage two.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
<td>April 2020</td>
<td>Designate a coordinator and manager for the development and implementation of the project.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coordination team</td>
<td>DGE/IndRE, CENAPRECE, CeNSIA, INSP</td>
<td>May 2020</td>
<td>DGVS for intersectoral coordination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methodological aspects: scenarios and diseases to include, geographical scope and study population</td>
<td>Diseases in the process of elimination. For vaccine-preventable diseases, targeted surveys at sites of interest are necessary. Consider selecting geographic areas using the vulnerability index developed in the country for other neglected infectious diseases</td>
<td>June 2020</td>
<td>To be defined based on analysis of the sample database</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol design (leadership role, time for design and approval)</td>
<td>DGE/IndRE, CENAPRECE, CeNSIA, INSP. Ethics committee approval will take at least 6 months in Mexico and an additional 2 months for PAHO. Consider structural changes.</td>
<td>December 2020</td>
<td>Draft and deliver protocol to ethics committees. Include changes to protocol (September 2020)</td>
<td>August-October 2020</td>
<td>DGVS in charge of intersectoral coordination</td>
<td>July-September 2020</td>
</tr>
</tbody>
</table>
### Components

<table>
<thead>
<tr>
<th>Countries</th>
<th>Mexico</th>
<th>Paraguay</th>
<th>Brazil</th>
</tr>
</thead>
</table>
| **Laboratory preparation** (supplies, review of procedures, quality control, etc.) | - Compile list of resources and supplies in stock and those still lacking to meet the requirements of stage two.  
- Reprocess samples to ensure familiarity with technique.  
- Validate any new equipment. | Fiscal year 2020-2021 (which begins in May)  
Ensure quality of buffers. Check and take stock of supplies to ensure needs are met. Note the possibility of creating a serum bank. Conduct external review. Have a national control panel in place for cutoff points. Transfer technology for bead manufacturing and validation. | November 2020  
Provide CDC with 500 samples for use in training | October 2020, if samples are available |
| **Selection of questionnaires and questionnaire capture platform** | Depends on proposals | May 2021  
- Country already has an electronic platform in place for collection of survey data.  
- Cross-reference survey information to identify which variables and data are collected and possible linkages. | November 2020 |
| **Fieldwork: supplies, logistics, team training, field supervision, etc.** | Depends on proposals | September 2021  
Will depend on methodology. Conduct pilot testing. Train supervisors so they can better support field teams. | February-March 2021  
Analysis of samples from the approved study, under CDC supervision | November 2020 |
| **Analysis of results** | December 2021-January 2022  
Transfer competencies so that the country can conduct data analysis, incorporating programs into analysis of results | April 2021  
Compile the study database | November-December 2020  
Interim data analysis and interpretation of results  
Presentation of results at the regional program meeting | February 2021  
March 2021 |

* Participating countries, in conjunction with PAHO/WHO and the U.S. CDC, will review the dates of the activities set out in this roadmap, which are expected to be delayed by the COVID-19 pandemic emergency and response.

CDC: U.S. Centers for Disease Control and Prevention; CENAPRECE: National Center for Prevention Programs and Disease Control; CeNSIA: Centro Nacional para la Salud de la Infancia y la Adolescencia; DGE/InDRE: Dirección General de Epidemiología/Institute of Epidemiological Diagnosis and Reference Dr. Manuel Martínez Báez; DGVS: Dirección General de Vigilancia de la Salud (Paraguay); INSP: National Public Health Institute (Mexico); PAHO: Pan American Health Organization.
In 2016, the Pan American Health Organization, in partnership with the U.S. Centers for Disease Control and Prevention, began a collaborative effort with delegates from Brazil, Mexico, and Paraguay aimed at transferring technical capacity for integrated serological surveillance of population immunity and transmission of multiple infectious diseases, using the multiplex bead assay (MBA) platform. MBA makes it possible to analyze the antibodies of up to 96 antigens of various pathogens in a single dried-spot blood sample. Serological surveillance is being increasingly used for its ability to generate information that helps characterize disease transmission and monitor the impact of interventions such as vaccination, and to identify susceptible populations.

This initiative has served as a learning process based on interprogrammatic work to develop integrated serological surveillance of various diseases and events that are often addressed separately from a programmatic standpoint, but which in reality overlap in the same population groups and geographical areas. This document presents the results of the third regional meeting, held in the city of Cuernavaca, Mexico, on 4-5 March 2020, and attended by delegates from the participating countries, partners, and stakeholders. This publication highlights the lessons learned during the first stage of capacity transfer, and discusses opportunities and next steps to expand integrated serological surveillance in the Region of the Americas as a tool for strengthening surveillance of communicable diseases.