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)

PAHO Pan American Health Organization
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Washington, D.C., 2020

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Contents

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

1

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.

2

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.

3

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.

4

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.

5

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 fromCDC and PAHO.

6

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.

7

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.

8

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.

9

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.

10

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.

11

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[i], 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.

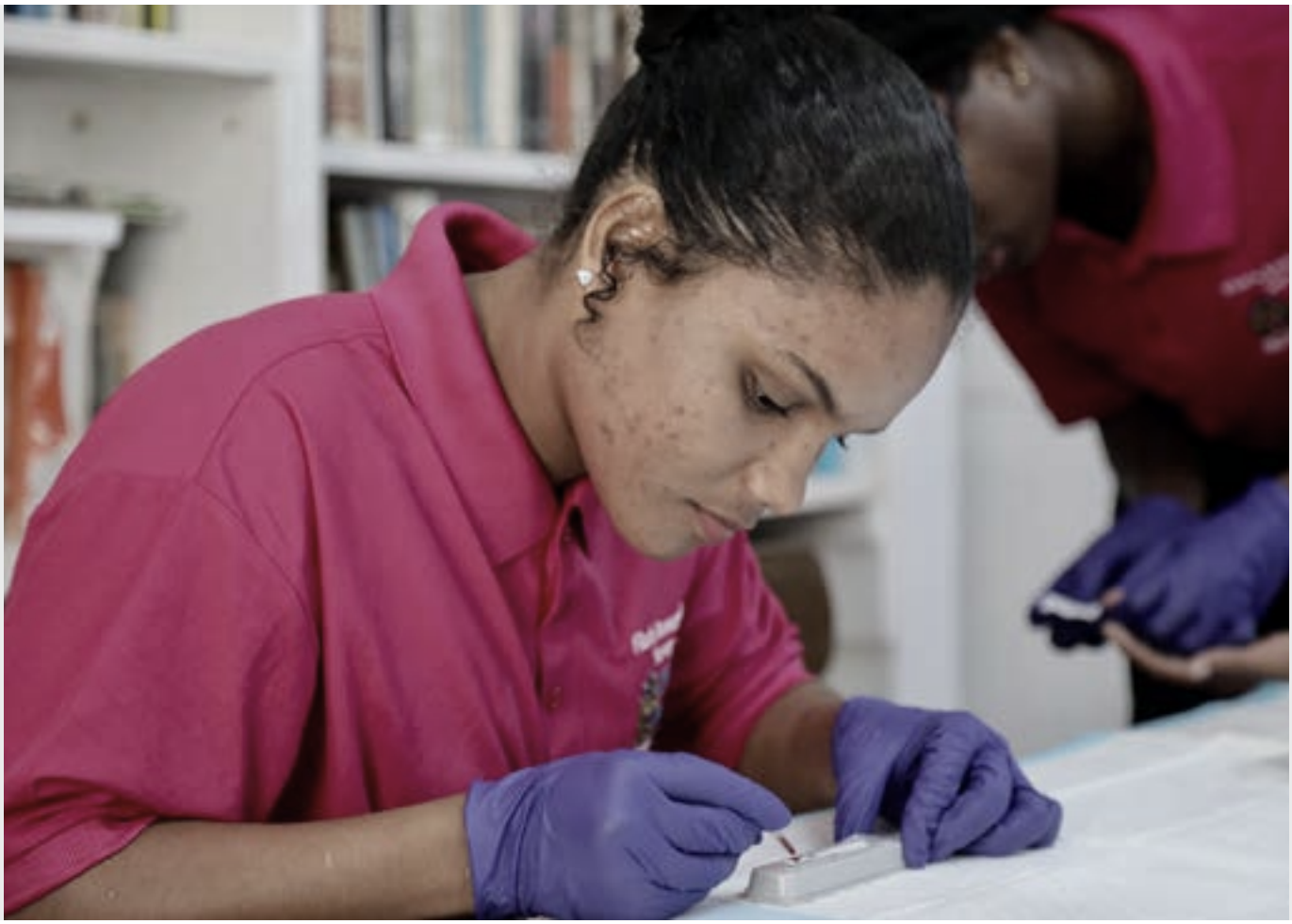
3. Opportunities for the use of integrated serological surveillance were identified, such as monitoring of zoonotic diseases of public health interest. Mexico expressed its interest in using the multiplex platform for post-elimination surveillance of human dog-mediated rabies, as the first country in 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.

i Pan American Health Organization. An Integrated, Sustainable Framework to Elimination of Communicable Diseases in the Americas. Concept Note. Washington, D.C.: PAHO; 2019. Available at: https://iris.paho.org/handle/10665.2/51106

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.



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Appendixes

Appendix 1.
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Appendix 2.
Meeting agenda

Wednesday, 4 March 2020

Time	Topic	Speaker or facilitator
Opening session		
9:00-9:30 a.m.	*Welcome address* PAHO/WHO Mexico Delegate of Mexican Secretariat of Health Delegate of National Public Health Institute (Mexico) Unit Chief, PAHO/WHO Neglected, Tropical and Vector Borne Diseases Unit	**Maria Jesús Sánchez** Mexico Health Section INSP Mexico **Luis Gerardo Castellanos**
	Objectives and agenda	Martha Saboyá, PAHO
9:30-10:00 a.m.	Elimination Initiative: Opportunities to Expand the Use of Integrated Serological Surveillance 20-minute presentation 10-minute discussion	Luis Gerardo Castellanos, PAHO
10:00-10:35 a.m.	Integrated serological surveillance of population immunity and disease transmission: background and regional initiative 25-minute presentation 10-minute discussion	Martha Saboyá, PAHO
Session 1. Progress and lessons learned from implementation of surveys on MBA-based integrated serological surveillance		
10:35-11:00 a.m.	Break	
11:00-11:45 a.m.	**Mexico: Survey results** 25-minute presentation 20-minute discussion	Delegate of Mexico
11:45 a.m.-12:15 p.m.	**Paraguay: Progress made in implementation of the survey** 20-minute presentation 20-minute discussion	Delegate of Paraguay
12:15-1:00 p.m.	**Brazil: Advances in protocol design** 20-minute presentation 25-minute discussion	Delegate of Brazil
1:00-2:00 p.m.	Lunch Break	
2:00-3:00 p.m.	Key lessons learned from the experience of Brazil, Mexico, and Paraguay (from protocols through fieldwork to use of results)	Plenary session led by Martha Saboyá (PAHO)
3:00-3:45 p.m.	Experience in other countries: Guyana and Guatemala 10-minute presentation (each) 25-minute discussion Can we expand this experience in 2020?	Ana Morice and Claudia Romo, PAHO external consultants
3:45-4:00 p.m	Break	
4:00-5:00 p.m.	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	Plenary session led by Luis Gerardo Castellanos (PAHO)

Thursday, 5 March 2020

Time	Topic	Speaker or facilitator
Session 2. Stage two of the initiative		
8:30-9:00 a.m.	Draft version of a best-practice manual for the implementation of surveys on integrated serological surveillance: progress	Martha Saboyá, PAHO
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

Feature	Multiplex initiative countries			Countries which have incorporated multiplex assays into existing surveys	
	Mexico	Paraguay	Brazil	Guyana	Guatemala
Sample design	Survey of selected schools, two-stage cluster sampling	Survey of selected schools, two-stage cluster sampling	A serum bank will be used (population and sample size TBD)	School-based survey. Evaluation units were defined and 100% of schools were included, with children selected by systematic or census-based sampling	Survey of selected schools, two-stage cluster sampling
Study population and sample size	1,012 randomly selected children (age 3-15 years) and 220 adults (age 18-30 years) selected by convenience sampling	1,200 children (age 6-15 years) selected randomly in schools		7,200 children (age 6-14 years) selected in six regions of the country; 33 evaluation units were defined, and the sample size for each was calculated on the basis of unit population size	Sample of 1,500 children (age 6-14 years) selected randomly from public schools across the country
Geographic areas	Six municipalities across three states (Chiapas, Morelos, and Sinaloa), selected by convenience	Chaco Paraguayo region (departments of Alto Paraguay, Boquerón and Presidente Hayes)		Guyana regions 1, 2, 6, 7, 8 and 9	Nationwide
Antigens included in the survey	11 antigens for malaria, trachoma, taeniasis/cysticercosis, measles, rubella, and diphtheria	14 antigens for trachoma, taeniasis/cysticercosis, strongyloidiasis, giardiasis, cryptosporidiosis, toxoplasmosis, measles, rubella, diphtheria, and tetanus	To be defined	18 antigens for lymphatic filariasis, malaria, strongyloidiasis, trachoma, yaws, taeniasis/cysticercosis, measles, rubella, diphtheria, and tetanus	20 antigens for malaria, onchocerciasis, strongyloidiasis, trachoma, giardiasis, taeniasis/cysticercosis, measles, rubella, diphtheria, and tetanus
Progress status (as of March 2020)	Data analysis	Database cleaning in progress	Protocol design review and adjustments	Samples at CDC waiting to be processed	Samples at CDC waiting to be processed
Next steps	Conclude data analysis and prepare report	Data analysis and preparation of report	Review and resubmit proposed protocol	Receive results from CDC; Data analysis and preparation of report	Receive results from CDC; Data analysis and preparation of report

Appendix 4.

Country roadmap for stage two of the initiative

Components	Countries					
	Mexico		Paraguay		Brazil	
	Activities	Date*	Activities	Date*	Activities	Date*
Analyze the need, rationality, and feasibility of conducting a population-based survey for serological surveillance of communicable diseases at stage two	▪ Consult program managers about their needs ▪ Identify already scheduled surveys to facilitate joint work. ▪ Analyze the feasibility of using banked serum samples. ▪ PAHO will send an official communication to Mexico regarding the formal start of stage two.	May 2020	▪ Meeting to start the analysis of results, with support from PAHO and CDC ▪ Workshop: presentation of results ▪ Begin process of identifying needs, rationality, and feasibility of implementing a survey based on epidemiological scenarios. ▪ Map out surveys the country already conducts (school health, oral health, etc.)	April–June 2020	Review the protocol to determine whether the proposed sample design is appropriate for stage two.	April 2020
Coordination team	DGE/InDRE, CENAPRECE, CeNSIA, INSP	May 2020	DGVS for intersectoral coordination		Designate a coordinator and manager for the development and implementation of the project.	April 2020
Methodological aspects: scenarios and diseases to include, geographical scope and study population	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	June 2020			To be defined based on analysis of the sample database	
Protocol design (leadership role, time for design and approval)	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.	December 2020	DGVS in charge of intersectoral coordination	August-October 2020	Draft and deliver protocol to ethics committees. Include changes to protocol (September 2020)	July-September 2020

Components	Countries					
	Mexico		Paraguay		Brazil	
	Activities	Date*	Activities	Date*	Activities	Date*
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	February 2021
					Presentation of results at the regional program meeting	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.

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