COVID-19 and its impact on the control of *Aedes (Stegomyia) aegypti* mosquito and epidemiological surveillance of arbovirus infections

Jorge Castañeda-Gómez,¹ Cassandra González-Acosta,² Jocelyn L. Jaime-Rodríguez,²
Alejandro Villegas-Trejo³ and Miguel Moreno-García^{2,4*}

¹State Vector Program, Servicios de Salud de Sonora, Hermosillo, Sonora; ²Coordination of Vector-borne Diseases and Zoonosis, Servicios de Salud de Morelos, Cuernavaca, Morelos; ³Asesoría y Capacitación en Salud Pública y Enfermedades Transmitidas por Vectores, S.A. de C.V., Cuernavaca, Morelos; ⁴Entomological Research and Bioassay Unit, Servicios de Salud de Morelos, Panchimalco Regional Vector Control Center, Jojutla, Morelos. México

Abstract

In American countries, simultaneously with the coronavirus disease 2019 (COVID-19) pandemic, epidemics caused by different arboviruses (dengue, chikungunya and Zika viruses) are occurring. In Mexico, several of the strategies to control the *Aedes aegypti* mosquito, which transmits arboviruses, involve the interaction of health personnel with the community. Due to the COVID-19 pandemic, social distancing and home confinement measures have been implemented. To obey these measures and avoid the risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) transmission, the National Center for Preventive Programs and Disease Control (CENAPRECE) has presented the vector control strategy in the scenario of simultaneous dengue and COVID-19 transmission in Mexico. In this work, we mention the routine comprehensive mosquito control measures and describe the adaptations that have been made. Furthermore, we discuss the relevance of medical personnel training and supervision, especially focusing on the similarity of symptoms between both pathologies.

KEY WORDS: Arboviruses. COVID-19. Comprehensive vector management. *Aedes aegypti*.

COVID-19 y su impacto en el control del mosquito *Aedes (Stegomyia) aegypti* y la vigilancia epidemiológica de infecciones por arbovirus

Resumen

En países americanos, simultáneas a la pandemia de enfermedad por coronavirus 2019 (COVID-19) se están dando epidemias ocasionadas por diferentes arbovirus (del dengue, chikunguña y virus del Zika). En México, varias de las estrategias para control del mosquito *Aedes aegypti*, transmisor de arbovirus, involucran la interacción del personal salubrista y los moradores. Debido a la pandemia de COVID-19 se han implementado medidas de distanciamiento social y resguardo domiciliario. Para respetar estas medidas y evitar riesgo de contagio por coronavirus 2 del síndrome respiratorio agudo grave (SARS-CoV-2), el Centro Nacional de Programas Preventivos y Control de Enfermedades (CENAPRECE) ha presentado la estrategia de control de vectores en el escenario de transmisión simultánea por dengue y COVID-19 en México. En este trabajo mencionamos las medidas habituales de manejo integral de mosquito y mencionamos las adaptaciones realizadas. De igual forma, discutimos la relevancia de la capacitación y la supervisión al personal médico, esto debido a la similitud entre la sintomatología entre ambas patologías.

PALABRAS CLAVE: Arbovirus. COVID-19. Manejo integrado de vectores. *Aedes aegypti*.

Correspondence:

*Miguel Moreno-García

E-mail: miguelmoga2000@yahoo.com.mx

Date of reception: 04-07-2020

Date of acceptance: 09-07-2020

DOI: 10.24875/GMM.M21000546

Gac Med Mex. 2021;157:187-193

Contents available at PubMed

www.gacetamedicademexico.com

0016-3813/© 2020 Academia Nacional de Medicina de México, A.C.. Published by Permanyer. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), had its origin in Wuhan, China, on December 2019, and spread in early 2020 across Europe, Oceania and the Middle East, to finally reach Africa.¹ In the region of the Americas, the first case was reported in the US (January 23, 2020);² subsequently, cases were detected in Canada and Latin American countries, with the first confirmed case of COVID-19 being recorded in Mexico on February 29, 2020.³ In March 2020, COVID-19 was declared a pandemic, with the negative impact on the health of the world population being evident.⁴

By the date this article is written (June 27, 2020), 54 American countries/territories have a total of 4,923,661 confirmed cases and 243,896 deaths.⁵ Given the severity of the pandemic, and due to the lack of vaccines or effective treatment, American governments have been implementing sanitary measures, with social distancing, home isolation and preventive measures such as correct hand washing being the main strategies to minimize viral transmission.⁶ This, in order not to collapse the health systems and decrease the incidence and lethality of infection.^{5,7} However, a side effect of the COVID-19 pandemic is the impact on other health programs, such as programs for the prevention and control of vector-borne infectious diseases (VBDs) (e.g. dengue, chikungunya, Zika, malaria, Chagas).⁸

In American countries located in tropical areas, along with the COVID-19 pandemic, VBD epidemics caused by different arboviruses (dengue, chikungunya and Zika) are simultaneously occurring.⁹⁻¹¹ Specifically, the disease caused by dengue virus (DENV), transmitted by the *Aedes aegypti* mosquito, which currently is the main viral disease transmitted by arthropods.¹² This situation is concerning in some Central American countries such as Costa Rica and Panama, since in the first half of the year 2020 they recorded a larger number of cases and higher incidence with regard to the same semester of previous year (Table 1).¹³ In addition to this, the World Health Organization estimates that each year there are between 50 and 100 million new cases of people infected by DENV in the world, as well as around 500,000 people with complications that require hospitalization, with 2.5 % dying.^{14,15} Particularly, in the

first semester of 2020, Mexico has recorded a larger number of cases and higher incidence with regard to the same semester of 2019 (Table 1).^{12,13} This, coupled with the COVID-19 pandemic, requires for the comprehensive vector management (CVM) strategies to be adapted in order to limit the negative impact of arboviruses on the vulnerable human population.^{16,17}

Control of *Aedes aegypti*, vector of dengue, chikungunya and Zika

In Mexico, strategies to fight *Aedes aegypti* are based on monitoring for its presence and population density by means of ovitraps,¹⁸ entomological studies¹⁹ and entomovirological surveillance (collection of adult mosquitoes for viral particles detection).²⁰ This allows establishing areas of risk for focusing health promotion activities with workshops and awareness-raising of the population, about physical and chemical control of the mosquito early phases (larvae),²¹ in a comprehensive way with junk-discarding actions (which consist of elimination of useless things that may become sites for oviposition and rearing of larvae indoors and outdoors). For probable and confirmed cases of dengue, residual insecticide spraying is applied indoors, as long as residents allow access during the contingency phase due to COVID-19.^{22,23} In the event of an arbovirus outbreak, as the last option for control, insecticides are applied on a large scale by misting with heavy vehicle-mounted equipment or personal thermal machines (thermal fogging).²⁴⁻²⁶

The described activities are carried out by health workers assigned to the health programs of each one of the 32 States, who carry them out inside and outside the houses, but these activities were restricted as a result of phase 3 of COVID-19 health contingency (Fig. 1).¹⁶ Before COVID-19, health personnel actively encouraged the participation of residents so that later they could be able to eliminate mosquito breeding sites and discard junk from their homes. However, owing to the strategy of home isolation and social distancing due to COVID-19, the Vector-borne Diseases Program of the National Center of Preventive Programs and Disease Control (CENAPRECE – *Centro Nacional de Programas Preventivos y Control de Enfermedades*) of the Ministry of Health of Mexico adapted these activities according to the pandemic phase (Table 2).²⁷ These adaptations limit all

Table 1. Panorama of dengue disease in Mexico, Central America and the Americas corresponding to the months of January, February, March, April, May and June (epidemiological weeks 1 to 27)

Country/region	2019				2020			
	Cases	Incidence*	Severe dengue	Deaths	Cases	Incidence*	Severe dengue	Deaths
Mexico	29,910	22.87	336	20	30,444	23.28	359	11
El Salvador	6,609	103.07	24	0	3,306	51.56	4	0
Costa Rica	2,425	48.96	0	0	3,729	75.29	8	0
Nicaragua	43,994	699.98	194	6	25,882	411.81	25	0
Panama	1,913	45.95	4	2	3,304	79.37	11	3
Belize	903	236.39	0	0	473 [†]	123.82 [†]	0 [†]	0 [†]
Guatemala	8,050	46.68	61	31	3,899	22.61	7	5
Honduras	30,099	328.66	6,795	51	15,372	167.85	1,265	9
The Americas	2,172,766	222.57	9,682	906	1,724,175	176.61	3,677	613

* Incidence rate per 100,000 population.

[†] Data up to epidemiological week 7.Created with data from the Pan American Health Organization, PLISA Health Information Platform for the Americas.¹⁹ **Figure 1.** Vector control comprehensive actions carried out by Mexico's health workers.

intra-domiciliary activities that are carried out in the dengue prevention and control program, in order to respect social distancing for the protection of residents and health workers, and thus avoid a potential risk of SARS-CoV-2 transmission. However, when said CVM activities require to be carried out, personal protection measures should be implemented, coupled with a healthy distance from the resident (1.5 meters), and shall be reinforced with continuous hand washing and handshake avoidance.²⁸

Social communication and health promotion

Raising public awareness is and will continue to be the most important strategy to combat both epidemics. Therefore, it is necessary to reinforce the dissemination of strategic campaigns focused on controlling and eliminating mosquito breeding sites, as well as on dengue and COVID-19 characteristic symptoms (Table 3),^{15,29-31} with the use of television spaces, social networks, radio, vehicle-mounted loudspeakers being recommended, for which active participation in social communication and health promotion is required.³² This is also intended to prevent the population from becoming reluctant to the different activities carried out by the health worker for vector control, which help to avoid an increase in mosquito population density (and, consequently, to reduce the probability of arbovirus infection).

Problems in vector-borne diseases epidemiological surveillance

In Mexico, epidemiological information is collected and integrated within the National Epidemiological Surveillance System (SINAVE – *Sistema Nacional de Vigilancia Epidemiológica*) and, in turn, it is monitored through different programs of the General Directorate of Epidemiology, a federal regulatory body of SINAVE,

Table 2. Proposal of activities for the control of *Aedes aegypti* in the face of the coronavirus disease 2019 (COVID-19) pandemic according to the phase (numbers of COVID-19 cases)

Activity	Phase 1 (tens of cases)	Phase 2 (hundreds of cases)	Phase 3 (thousands of cases)
Entomological surveillance with ovitraps	Normal activity, generation of report on readings Personal protection with face mask	Normal activity in dengue risk zones, generation of report on readings Personal protection with face mask	Activity limited to dengue high risk zones, generation of report on readings for decision making Personal protection with face mask
Entomological investigations	Normal activity, generation of report on readings Personal protection with face mask	Activity limited to zones with arbovirus outbreaks Personal protection with face mask	Suspended activity
Entomovirological surveillance	Normal activity, generation of report on readings Personal protection with face mask	Activity restricted to homes without probable or confirmed cases of dengue Personal protection with face mask	Suspended activity
Larval control	Normal activity, generation of report on readings Personal protection with face mask	Activity restricted to homes without probable or confirmed cases of dengue Personal protection with face mask	Suspended activity
Indoor spraying for probable/confirmed cases of dengue.	Normal activity Personal protection with gloves, goggles, face mask and face shield	Activity limited to thermal fogging inside the home and around the block of the dengue case, and fogging with heavy duty ULV fogger Personal protection with overalls, gloves, goggles, face mask and face shield	Thermal fogging activity inside the home of the dengue case; if confirmed, the area is extended to 9 blocks around Personal protection with overalls, gloves, goggles, face mask and face shield
Space fogging (heavy duty ULV fogger)	Normal activity Personal protection with overalls, face mask, gloves and goggles	Activity to reinforce with higher coverage in areas with probable cases Personal protection with overalls, face mask, gloves and goggles	Attention to localities with historical epidemiological risk, weekly fogging for four weeks to the entire transmission area. Attention with a fogging cycle after a massive junk disposal campaign in at-risk localities. Personal protection with overalls, gloves, goggles, face mask and face shield
Thermal fogging	Normal activity Personal protection with gloves, goggles, face mask and face shield	Activity targeting the house and block of probable/confirmed dengue case Personal protection with overalls, gloves, goggles, face mask, face shield	Attention to blocks with entomological risk (ovitraps with a larger number of eggs), attention by probable case according to the case classification In areas where the vehicle with heavy equipment does not have access, personal protection with overalls, gloves, goggles, face mask and face shield

ULV = ultra-low volume.

Based on and adapted from Centro Nacional de Programas Preventivos y Control de Enfermedades, 2020.²⁷

which, together with the state and jurisdictional counterparts of each one of these programs, analyze, evaluate and disseminate said information in order to generate strategies and actions for the management and control of diseases that represent relevant risks to public health. Epidemiological information comes from primary and secondary care institutions that belong to the National Health System of the entire country (20,005 units).³³

For arboviruses surveillance, first-contact doctors of the different health institutions are in charge of

notifying probable cases to the corresponding health jurisdiction, which, in turn, notifies at the state level (NOM-017-SSA2-2012 standard, for epidemiological surveillance).³⁴ This is how VBD prevention and control strategies go hand in hand with epidemiological surveillance, since with continuous notification of cases (on a daily basis), Health Services of each State focus, plan and stratify different actions for the control of mosquitoes at their region.

During the COVID-19 pandemic, training and supervision of medical personnel are of vital importance for

Table 3. Symptoms caused by the dengue virus and SARS-CoV-2

Non-severe dengue with no signs of alarm	Non-severe dengue with signs of alarm	Severe dengue	COVID-19
<ul style="list-style-type: none"> – Fiebre – Headache – Retro-orbital pain – Muscle pain – Joint pain – Bone pain – Nausea – Vomiting – Lymph node enlargement – Rash 	<ul style="list-style-type: none"> – Intense and continuous abdominal pain – Persistent vomiting – Build-up of fluid – Gums and nose bleeding – Weakness and somnolence – Low blood pressure and sensation of dizziness – Irritability or restlessness 	<ul style="list-style-type: none"> – Shortness of breath – Organ failure (liver, kidney, etc.) – Intense abdominal pain – Severe bleeding – Accelerated respiratory and heart rate – Presence of blood in vomit and stools – Cold extremities – Weak or undetectable pulse – Build-up of fluid 	<p>Most common symptoms:</p> <ul style="list-style-type: none"> – Fever – Dry cough – Headache – Tiredness and/or muscle pain <p>Less frequent symptoms:</p> <ul style="list-style-type: none"> – Nasal congestion and/or discharge – Conjunctivitis – Sore throat – Diarrhea – Loss of taste and/or smell – Rashes – Change of color in fingers or toes <p>Severe symptoms:</p> <ul style="list-style-type: none"> – Shortness of breath – Chest pain – Speech disorder

SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2; COVID-19 = coronavirus disease 2019.

Adapted from World Health Organization, 2020;^{15,29} Centers for Disease Control and Prevention, 2019;³⁰ Pan American Health Organization.³¹

strengthening epidemiological surveillance and arboviruses correct clinical management, since if these activities are deficient in endemic regions, it could result in an epidemiological silence that would prevent accurate data from being obtained. Similarly, an incorrect classification and treatment of patients could occur due to the existence of similar symptoms between dengue and COVID-19 (Table 3),³⁵ with greater complications and even deaths in patients with this VBD being generated.

In addition to fever, shared observable symptoms include: thrombocytopenia (platelet count decrease),³⁵ petechiae (skin vascular effusions),³⁶ morbilliform exanthem (rash),³⁷ headache, myalgia (muscle pain), and arthralgia (joint pain).³⁸ There is scientific evidence that SARS-CoV-2 infection can generate false positive results in diagnostic serological tests for dengue;³⁵ therefore, in case of possible confusion, to avoid complications in the patient, using a RT-PCR test for both diseases and avoiding diagnosis with serological test is recommended, and emphasis is made on the warning signs of both pathologies, i.e., intense and continuous abdominal pain in dengue and dyspnea in COVID-19. These symptomatic characteristics are relevant for detecting, classifying and clinically treating both diseases, in addition to the fact that, due to the characteristics in the form of transmission, a mortality decrease is expected owing

to the organization and management of patients at hospital care centers.

Conclusion

For tropical countries, including Mexico, the rainy season starts at the end of May, whereby the epidemic stage of dengue and other VBDs also begins. It is during this period that a rebound in COVID-19 cases is also expected in several regions of the country that are highly endemic for dengue. Countries' health systems face the challenge of combining usual health programs with strategies to combat the COVID-19 pandemic, and the study and management of patients will therefore be crucial to reduce mortality of both diseases.

COVID-19 natural history is still unknown, and although information is being rapidly generated, it is uncertain when the high-transmission stage will end. For this reason, it is necessary to urgently organize and synchronize the actions to control the vector and SARS-CoV-2 that do not require contact between citizens and health workers, such as space spraying and thermal fogging, in order to reduce the density of the mosquito in as much as possible. Furthermore, for an adequate impact and to establish risk zones with the highest accuracy, reinforcement of epidemiological surveillance and clinical management of patients is required in order to obtain valuable information and decrease mortality.

All sources of information are public in nature and have the sole purpose of providing specific information. The conclusion represents the opinion of the authors and not of the affiliation institutions.

Conflict of interests

The authors declare that they have no conflicts of interest.

Funding

This document had no funding source, either public or private.

Ethical disclosures

Protection of human and animal subjects. The authors declare that no experiments were performed on humans or animals for this research.

Confidentiality of data. The authors declare that they have followed the protocols of their work center on the publication of patient data.

Right to privacy and informed consent. The authors declare that no patient data appear in this article.

References

- Coronavirus disease 2019 (COVID-19). Situation report-26, 15 February 2020 [Internet]. Geneva, Switzerland: World Health Organization; February 15, 2020 [accessed: June 27, 2020]. Available at: https://www.who.int/docs/default-source/coronavirus/situation-reports/20200215-sitrep-26-covid-19.pdf?sfvrsn=a4cc6787_2
- Novel Coronavirus (2019-nCoV). Situation report-3, 23 January 2020 [Internet]. Geneva, Switzerland: World Health Organization; January 23, 2020 [accessed: June 20, 2020]. Available at: https://www.who.int/docs/default-source/coronavirus/situation-reports/20200123-sitrep-3-2019-ncov.pdf?sfvrsn=d6d23643_8
- Coronavirus disease 2019 (COVID-19). Situation report-40, 29 February 2020 [Internet]. Geneva, Switzerland: World Health Organization; February 29, 2020 [accessed: June 20, 2020]. Available at: https://www.who.int/docs/default-source/coronavirus/situation-reports/20200229-sitrep-40-covid-19.pdf?sfvrsn=849d0665_2
- Alocución de apertura del Director General de la OMS en la rueda de prensa sobre la COVID-19 celebrada el 11 de marzo de 2020 [Internet]. Geneva, Switzerland: Organización Mundial de la Salud; March 11, 2020 [accessed: June 23, 2020]. Available at: <https://www.who.int/es/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020>
- Coronavirus disease (COVID-19). Situation report-159, 27 June 2020 [Internet]. Geneva, Switzerland: World Health Organization; June 27, 2020 [accessed: June 27, 2020]. Available at: https://www.who.int/docs/default-source/coronavirus/situation-reports/20200627-covid-19-sitrep-159.pdf?sfvrsn=93e027f6_2
- Pass the message: five steps to kicking out coronavirus, 23 March 2020 [Internet]. Geneva, Switzerland: World Health Organization; March 23, 2020 [accessed: June 22 2020]. Available at: <https://www.who.int/news-room/detail/23-03-2020-pass-the-message-five-steps-to-kicking-out-coronavirus>
- Coronavirus Resource Center. Johns Hopkins University and Medicine [Internet]. Johns Hopkins University and Medicine; 2020 [accessed: June 25 2020]. Available at: <https://coronavirus.jhu.edu/map.html>
- La OMS publica directrices para ayudar a los países a mantener los servicios sanitarios esenciales durante la pandemia de COVID-19 [Internet]. Geneva, Switzerland: World Health Organization; 2020 [accessed: June 26, 2020]. Available at: <https://www.who.int/es/news-room/detail/30-03-2020-who-releases-guidelines-to-help-countries-maintain-essential-health-services-during-the-covid-19-pandemic>
- Wenham C, Lotta G, Pimenta D. Mosquitoes and COVID-19 are a ticking time bomb for Latin America [Internet]. The London School of Economics and Political Science; March 31, 2020 [accessed: June 19, 2020]. Available at: <https://blogs.lse.ac.uk/latamcaribbean/2020/03/31/mosquitoes-and-covid-19-are-a-ticking-time-bomb-for-latin-america>
- Lago M. América Latina puede convertirse en la mayor víctima del COVID-19 [Internet]. The New York Times; March 19, 2020 [accessed: June 15, 2020]. Available at: <https://www.nytimes.com/es/2020/03/19/espanol/opinion/coronavirus-america-latina-gobiernos.html>
- Boris M. Por qué América Latina está registrando "la mayor epidemia de dengue de su historia" [Internet]. BBC news Mundo; February 13, 2020 [accessed: June 19, 2020]. Available at: <https://www.bbc.com/mundo/noticias-51496280>
- Actualización epidemiológica: Dengue, 23 de marzo de 2020 [Internet]. Washington, D.C.: Organización Panamericana de la Salud; March 23, 2020 [accessed: June 24, 2020]. Available at: <https://www.paho.org/es/documentos/actualizacion-epidemiologica-dengue-23-marzo-2020>
- Casos Dengue [Internet]. Washington, D.C.: Organización Panamericana de la Salud, PLISA Plataforma de Información en Salud para las Américas [accessed: June 26, 2020]. Available at: <https://www.paho.org/data/index.php/es/temas/indicadores-dengue/dengue-nacional/9-dengue-pais-ano.html>
- Dengue [Internet]. Washington, D.C.: Pan American Health Organization [accessed: June 24, 2020]. Available at: <https://www.paho.org/en/topics/dengue>
- Dengue and severe dengue [Internet]. Geneva, Switzerland: World Health Organization; June 23, 2020 [accessed: June 26, 2020]. Available at: <https://www.who.int/news-room/fact-sheets/detail/dengue-and-severe-dengue>
- Handbook for integrated vector management in the Americas. 2019 [Internet]. Washington, D.C.: Pan American Health Organization; 2019 [accessed: June 21, 2020]. Available at: https://iris.paho.org/bitstream/handle/10665.2/51759/Manejo_%20Integrado_ENG_FINAL3.pdf?sequence=1&isAllowed=y
- Malaria and the COVID-19 pandemic. 8 June 2020 [Internet]. Geneva, Switzerland: World Health Organization; June 8, 2020 [accessed: June 27, 2020]. Available at: <https://www.who.int/news-room/q-a-detail/malaria-and-the-covid-19-pandemic>
- Guía Metodológica para la Vigilancia Entomológica con Ovitrapas. 2018 [Internet]. Mexico City, Mexico: Centro Nacional de Programas Preventivos y Control de Enfermedades; 2018 [accessed: June 22, 2020]. Available at: https://www.gob.mx/cms/uploads/attachment/file/354685/Guia_Metodologica_para_Vigilancia_Entomologica_con_Ovitrapas.pdf
- Guía Metodológica para Estudios Entomológicos en Fase Larvaria y Pupal. 2018 [Internet]. Mexico City, Mexico: Centro Nacional de Programas Preventivos y Control de Enfermedades; 2018 [accessed: June 22, 2020]. Available at: https://www.gob.mx/cms/uploads/attachment/file/399677/Guia_Metodologica_para_Estudios_Entomologicos_en_Fase_Larvaria_y_Pupal.pdf
- Guía Metodológica para la Vigilancia Entomoviroológica. 2018 [Internet]. Mexico City, Mexico: Centro Nacional de Programas Preventivos y Control de Enfermedades; 2018 [accessed: June 23, 2020]. Available at: https://www.gob.mx/cms/uploads/attachment/file/354682/Guia_Metodologica_para_la_Vigilancia_Entomoviroologica.pdf
- Guía Metodológica para las Acciones de Control Larvario. 2018 [Internet]. Mexico City, Mexico: Centro Nacional de Programas Preventivos y Control de Enfermedades; 2018 [accessed: June 23 2020]. Available at: https://www.gob.mx/cms/uploads/attachment/file/355418/Guia_Metodologica_para_las_Acciones_de_Control_Larvario.pdf
- Guía Metodológica para el Rociado Domiciliario. 2018 [Internet]. Mexico City, Mexico: Centro Nacional de Programas Preventivos y Control de Enfermedades; 2018 [accessed: June 22, 2020]. Available at: https://www.gob.mx/cms/uploads/attachment/file/354678/Guia_Metodologica_para_el_Rociado_Domiciliario.pdf
- Indoor residual spraying, an operational manual for indoor residual spraying (IRS) for malaria transmission control and elimination. 2015 [Internet]. Geneva, Switzerland: World Health Organization; 2015 [accessed: June 19, 2020]. Available at: https://apps.who.int/iris/bitstream/handle/10665/177242/9789241508940_eng.pdf?sequence=1&isAllowed=y
- Guía de Nebulización (Rociado Espacial) para la Aplicación de Insecticida a Ultra Bajo Volumen (UBV) con Equipo Pesado. 2018 [Internet]. Mexico City, Mexico: Centro Nacional de Programas Preventivos y Control de Enfermedades; 2018 [accessed: June 20, 2020]. Available at: https://www.gob.mx/cms/uploads/attachment/file/354684/Guia_Metodologica_para_Nebulizacion_Espacial_UBV.pdf
- Guía de Nebulización Térmica para la Aplicación de Adulticida con Equipo Portátil. 2018 [Internet]. Mexico City, Mexico: Centro Nacional de Programas Preventivos y Control de Enfermedades; 2018 [accessed: June 21, 2020]. Available at: https://www.gob.mx/cms/uploads/attachment/file/354680/Guia_Metodologica_para_la_Nebulizacion_Termica.pdf

26. Space spray application for insecticides for vector and public health pest control, a practitioner's guide. 2020 [Internet]. Geneva, Switzerland: World Health Organization; 2020 [accessed: June 23, 2020]. Available at: https://apps.who.int/iris/bitstream/handle/10665/68057/WHO_CDS_WHOPES_GCDPP_2003.5.pdf?sequence=1 and isAllowed=y
27. Estrategia de control de vectores en el escenario de transmisión simultánea Dengue y COVID-19 en México. 2020 [Internet]. Mexico City, Mexico: Centro Nacional de Programas Preventivos y Control de Enfermedades; 2020 [accessed: June 18, 2020]. Available at: https://www.gob.mx/cms/uploads/attachment/data/file/551912/Estrategia_Control_Vectores_COVID-19_Mexico.pdf
28. Coronavirus (COVID-19) Comunicado técnico diario. 2020 [Internet]. Mexico City, Mexico: Secretaría de Salud; 2020 [accessed: June 24, 2020]. Available at: <https://www.gob.mx/salud/documentos/coronavirus-covid-19-comunicado-tecnico-diario-238449>
29. Preguntas y respuestas sobre la enfermedad por coronavirus (COVID-19) [Internet]. Geneva, Switzerland: World Health Organization; 2020 [accessed: June 27, 2020]. Available at: https://www.who.int/es/emergencias/diseases/novel-coronavirus-2019/advice-for-public/q-a-coronaviruses?gclid=CjwKCAjwTqj2BRBYEiwAqf-zur6zr-xgyf8-Aqxc823KuVvI5OXvV24iiV2AlDeXYbalvBn8JTtXoUxoC-kxsQAvD_BwE
30. Dengue. 2019 [Internet]. Georgia, United States: Centers for Disease Control and Prevention; 2019 [accessed: June 27 2020]. Available at: <https://www.cdc.gov/dengue/es/symptoms/index.html>
31. Dengue: información general [Internet]. Washington, D.C.: Organización Panamericana de la Salud [accessed: June 27 2020]. Available at: https://www.paho.org/hq/index.php?option=com_content&view=article&id=4493:2010-informacion-general-dengue&Itemid=40232&lang=es
32. Planificación de la movilización y comunicación social para la prevención y control del Dengue. 2004 [Internet]. Geneva, Switzerland: World Health Organization; 2004 [accessed: June 20, 2020]. Available at: https://www.who.int/tdr/publications/documents/planificacion_dengue.pdf
33. Sistema Nacional de Vigilancia Epidemiológica. 2020 [Internet]. Mexico City, Mexico: Gobierno de México [accessed: June 20, de 2020]. Available at: <https://www.gob.mx/salud/acciones-y-programas/sistema-nacional-de-vigilancia-epidemiologica>
34. Diario Oficial de la Federación. Norma Oficial Mexicana NOM-017-SSA2-2012, para la vigilancia epidemiológica. 2013 [Internet]. Mexico City, Mexico: Gobierno de México [accessed: June 19, 2020]. Available at: http://dof.gob.mx/nota_detalle.php?codigo=5288225&fecha=19/02/2013
35. Yan G, Lee CK, Lam LTM, Yan B, Chua YX, Lim AYN, et al. Covert COVID-19 and false-positive dengue serology in Singapore. *Lancet Infect Dis.* 2020;20(5):536.
36. Joob B, Wiwanitkit V. Hemorrhagic problem among the patients with COVID-19: Clinical summary of 41 Thai infected patients. *Clin Appl Thromb Hemost.* 2020;26. <https://doi.org/10.1177/1076029620918308>
37. Joob B, Wiwanitkit V. COVID-19 can present with a rash and be mistaken for Dengue. *J Am Acad Dermatol.* 2020;83(5):e177.
38. Joob B, Wiwanitkit V. Arthralgia as an initial presentation of COVID-19: observation. *Rheumatol Int.* 2020;40:823.