

# Domestic Dogs as Sentinels for West Nile Virus, Mexico

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

[Sarah Gregory] Hello, I'm Sarah Gregory, and today I'm talking with Dr. Gabriel Hamer, an associate professor of entomology at Texas A&M University. We'll be discussing domestic dogs as sentinels for West Nile virus in Mexico. And Dr. Hamer is calling from Guatemala today.

Welcome, Dr. Hamer.

[Gabriel Hamer] Thank you, nice to be here.

[Sarah Gregory] You tested domestic pet dogs in Mexico for neutralizing antibodies for mosquito-borne flaviviruses, specifically West Nile virus, Zika, and dengue. Tell us about the different mosquitoes involved in these infections.

[Gabriel Hamer] Sure. So West Nile virus is a very common virus throughout the United States. It's transmitted by *Culex* mosquitoes that feed on birds, and in the southern United States and in Mexico, mainly *Culex quinquefasciatus* or the southern house mosquitoes. Zika and dengue and some other viruses are referred to as *Aedes*-borne viruses. And so they're transmitted mainly by *Aedes aegypti*, which is common throughout many tropical and subtropical regions of the world.

[Sarah Gregory] And why dogs and not cats?

[Gabriel Hamer] Well, some of our studies looking at mosquito feeding patterns were showing that these mosquitoes were feeding more on dogs than on cats. So that was one motivation. Another was that dogs tend to be a little bit more common in these household studies throughout Mexico. And then also, dogs are a little easier to sample than cats, as well.

[Sarah Gregory] Do these infections affect dogs the same way as they affect people?

[Gabriel Hamer] Fortunately, for at least these mosquito-borne viruses that we were studying, there's certainly a lot of evidence that dogs can get exposed, and they develop antibodies and seroconvert. But there's not a lot of cases where dogs are showing clinical signs of illness. So fortunately, evidence of disease is less common in dogs compared to humans.

[Sarah Gregory] Let's just talk about people for a second, then. Are there treatments for these three viruses?

[Gabriel Hamer] So for people, there are options (for example, antiviral medications that can be taken). But unfortunately, one of the reasons why there's such a problem throughout the world is there's not a lot of vaccines or therapeutics that can be taken to help protect or remove infections. And that's also true for pets. There's not a lot of options for supportive...beyond supportive care for dogs. Fortunately for horses, there are some vaccines that are effective for not just West Nile virus, but some other similar encephalitis viruses.

[Sarah Gregory] I know we've done a couple of podcasts recently on Hendra virus, and there's a vaccine for that. So that's some good news out there.

You previously looked at *Aedes* and *Culex* mosquitoes feeding patterns. How did your findings from that research influence this study?

[Gabriel Hamer] Us seeing these results of mosquitoes feeding on dogs in south Texas and northern Mexico, that's where we wanted to look elsewhere to see how often this is happening and not just dog exposure to mosquitoes, but also the associated viruses.

[Sarah Gregory] Why did you choose Mexico to conduct this study?

[Gabriel Hamer] In the United States, we have very little *Aedes*-borne virus transmission. So Florida and Texas are the only states with occasional local transmission of, say, dengue or Zika, but not really enough to conduct this kind of study. We needed to go to an area that's more considered endemic for dengue and these other viruses, and so that's why we developed collaborations with partners in Mexico.

[Sarah Gregory] I'm sure most people are familiar by now with the term "antibody", but what exactly are neutralizing antibodies?

[Gabriel Hamer] We didn't have any commercially available serology kit, for example, with these dog samples. So we really had to do more of a traditional or gold standard neurological assay, and how that works is you basically in a lab combine the dog's blood with live virus in cell culture. And if that dog had been previously exposed to these viruses and developed antibodies, the presence of those antibodies are going to prevent the viral growth or prevent the formation of viral plaque. And that's why the antibodies are neutralizing the growth of the virus.

[Sarah Gregory] Do these neutralizing antibodies protect against future cases?

[Gabriel Hamer] So usually if a person or an animal has a high neutralizing antibody titer for a given virus, that usually means they also then are going to be protected from future exposures.

[Sarah Gregory] Were there specific dog breeds that you sampled for your study?

[Gabriel Hamer] We generally...we went into communities, and we were interested in really bleeding and obtaining samples from all the dogs present. But in these communities in Mexico, that tended to be mixed breeds or chihuahuas or pit bulls.

[Sarah Gregory] Theoretically, could different dog breeds be more or less susceptible to mosquito-borne viruses due to different genetic traits?

[Gabriel Hamer] So for a lot of these viruses in particular, and even a number of other infectious agents, there's often not a lot of associations with particular breeds. A lot of them are similarly susceptible. And so, in our case, in this study we did not see any differences in these antibodies broken down by different breeds.

[Sarah Gregory] These were just blood tests, right? No animal cruelty was involved?

[Gabriel Hamer] So we usually go house to house in these communities and ask permission from the homeowners if we can obtain these samples and explain the project, and then we get consent from those pet owners. And usually the owners are right there present while we're working with the animals. And then, of course, we let them go when we're done.

[Sarah Gregory] Your study is particularly about dogs being sentinels for West Nile virus. Explain what a sentinel would be in this context.

[Gabriel Hamer] So sentinels, in this case, would be a scenario where an animal could be a signal or a proxy for human exposure to an infectious agent. And the beauty about using a sentinel or these signals is sometimes you can see evidence of, say, circulation of a virus before humans get

exposed. So that could allow you time to take action. And then, also sometimes these sentinels are just easier to sample, maybe sampling pets is a little bit easier than people.

[Sarah Gregory] Tell us a little bit more about your study and how you went about it.

[Gabriel Hamer] We developed collaborations with universities in Mexico. So this is principally Héctor Ochoa and ECOSUR, and Mario Rodríguez and José Estrada-Franco—they are at Instituto Politécnico Nacional, and that is in Tamaulipas, Mexico. And so, through those partnerships, we had obtained all the permits to...for their teams to sample dogs. They ended up with close to 300 dog blood samples. We obtained those dog blood samples and then did the assay in our lab at Texas A&M—and again, that's called the Plaque Reduction Neutralization Test—to look for the presence of antibodies.

[Sarah Gregory] What did you find?

[Gabriel Hamer] Given those observations of mosquitoes feeding on dogs, we were expecting that these *Aedes aegypti*-borne viruses (such as dengue and Zika)... we were expecting to find neutralizing antibodies for those viruses. Instead, we did not. We did find a small number of dogs that showed evidence of exposure to dengue, and then maybe also Zika. But overall, most of them did not have those antibodies. But we did...while testing for West Nile virus, we were a little bit surprised to find a very high prevalence or seroprevalence of antibodies in these dogs in northern Mexico, but not southern Mexico.

[Sarah Gregory] Why might dogs be more likely to be sentinels for West Nile virus, but not Zika or dengue?

[Gabriel Hamer] I think the potential for dogs or even any kind of other animal to play the role of sentinels is probably very context dependent. First, there needs to be a lot of the presence of the infectious agent being transmitted by mosquitoes locally. And then, those mosquitoes that are infected need to feed on these animals. And so for West Nile virus, it does appear, like in northern Mexico. In Reynosa, we had scenarios where we had a lot of virus transmission, and those mosquitoes were feeding on dogs. But that did not appear to be the case for *Aedes aegypti* and associated viruses.

[Sarah Gregory] But we don't know why that those mosquitoes weren't feeding on dogs. There's no part of your study that tells us that, right?

[Gabriel Hamer] Right. So in southern, we weren't doing the blood analysis associated with this dog study. And so, that could have been one explanation...just the virus could have been present, there could have been virus-positive mosquitoes, but they weren't being fed on by local...by the *Aedes aegypti*.

[Sarah Gregory] Although West Nile virus neutralizing antibodies were found in a high number of pet dogs, the number of reported cases in people remained low. Why do you think this is?

[Gabriel Hamer] Probably one of the main issues could simply be what is referred to as reporting bias or misdiagnosis. There's a lot of febrile illnesses that could result in symptoms that are similar to West Nile virus fever. And these could be mistaken for another illness and then either just not get tested or go unreported. One other dimension that could be happening in Mexico, a lot of people living there are commonly exposed to many different flaviviruses. So that's the family that all these viruses occur in, and that includes dengue and Zika and West Nile virus.

And once they get exposed to one, that might actually help protect them against exposure to other flaviviruses, in which case they would not have as much disease.

[Sarah Gregory] It was my understanding that you could get West Nile virus repeatedly. Is that wrong?

[Gabriel Hamer] With dengue, for sure. That's because there's multiple serotypes of dengue. So that...people can repeatedly get sick with dengue. For West Nile virus, for the most part, people, once they're exposed, they do produce antibodies and are likely less susceptible for at least a while. We may not know how long that protection would last.

[Sarah Gregory] What are the public health implications of your findings?

[Gabriel Hamer] We know Texas has a lot of West Nile virus. There's a lot of even cases occurring in larger cities like Houston or Dallas. But as you go south into Mexico, either there's less virus transmission or there continues to be virus transmission and we just notice less human disease. So the study in northern Mexico where we're looking at dog exposure to West Nile virus, that's showing evidence that there's a lot of circulating West Nile virus in that area. And then that leaves the question as to why there's not the associated human disease, which we just discussed. So either cases are going underreported or humans in those communities had already been exposed to dengue or Zika and then just are less susceptible to West Nile virus.

[Sarah Gregory] I think you mentioned one, so what were the surprises?

[Gabriel Hamer] I guess we had a couple. One, we were expecting to see more evidence of dog exposure to the *Aedes*-borne viruses, given that at least in some cases, *Aedes aegypti* are feeding heavily on dogs. We did not see that, so that's surprising. But then we were also surprised by nearly 50% of dogs in Reynosa had been exposed to West Nile virus. You don't hear a lot about West Nile virus. There's been actually very few reported cases in people in Mexico in general (including northern Mexico). So I think that is a surprise and it certainly suggests that the virus is present and circulating.

[Sarah Gregory] There must have been many challenges in doing this study. What were they?

[Gabriel Hamer] So one challenge would just be simply logistics. We have a large team, it's international, and we needed to ship these samples from Mexico to the United States. So just having all the export and import permits took quite a while. So that's certainly a challenge.

[Sarah Gregory] Mosquito repellent is a staple during the warmer months. Is there a mosquito repellent that's safe for using on dogs?

[Gabriel Hamer] So repellents that may only last a few hours are often not used. Instead, we focus on what are going to be the pathogens that these mosquitoes and ticks and fleas could transmit that could hurt dogs, and they certainly do exist. Dog heartworm, for example, is one very important one. So there's...very commonly, dogs (any kind of dog) receiving veterinary care would be on a preventative for dog heartworm in the United States. So that's one example of protection. There's also a lot of other flea and tick preventatives as well that are often systemic insecticides where the dog obtains that medicine, and then that helps to essentially kill the ticks or fleas that are feeding on the dog.

[Sarah Gregory] You mentioned that dogs seem to be pretty much asymptomatic for West Nile virus. So either way, in symptomatic or asymptomatic, can an infected pet dog transmit this infection to owners?

[Gabriel Hamer] For these viruses, there's not really evidence that a dog is going to produce a high titer or a high amount of the virus in the blood. And so, because of that...I mean, that's good in the sense that that's going to reduce the risk of those dogs re-infecting mosquitoes or resulting in some kind of dog-to-human transmission event. So basically for these viruses, that's not even possible.

[Sarah Gregory] Generally speaking then, what are the best ways that people can protect themselves from mosquito bites? And their dogs, even without the pills or with them.

[Gabriel Hamer] For people, avoiding high risk scenarios like avoiding going outdoors or in locations where mosquitoes are feeding. Or if they are going in that scenario, wearing long pants or long clothes or wearing repellent. That's certainly some things that humans can do. Adding screens to windows, that's important as well for households. For pets, it would be a similar set of recommendations. Certainly, those products that control against ticks and fleas might also help protect against these other mosquito-associated diseases.

[Sarah Gregory] So you're in the field right now. What kind of clothing do you have on? How are you protecting yourself?

[Gabriel Hamer] We're in rural communities in Guatemala, and they had seen a lot of *Culex* mosquitoes and *Aedes aegypti* inside of homes. A lot of them are filled up with blood. We're collecting those blood-engorged mosquitoes for the research we're doing. So yeah, long clothing on, long pants, long shirts. I've even treated our clothing with permethrin—so, an insecticide or a repellent that will help protect us.

[Sarah Gregory] I heard at the beginning of the pandemic that CDC was working with partners to develop a grapefruit-based repellent. It was supposed to be coming out this year. Have you heard anything about that? I haven't heard anything more.

[Gabriel Hamer] Definitely a lot of research groups are continuing to advance the mosquito repellent research arena that ultimately, in many cases, the goal is to leak their commercial products. Certainly, for a long time, DEET...that's been one of the very effective repellent that's been used for many years. But there's always the goal of developing alternative repellents or ones that may be slightly safer. And so, like you said, grapefruits, tomatoes, these have a...an extract that has repellent properties. And several of those, though, do make it to the market. There's a lot of different oils as well that are used. In fact, here in Guatemala, my wife didn't find any DEET-related products. I would see various essential oils on the shelf.

[Sarah Gregory] Well, speaking of your fieldwork, tell us about your job and your fieldwork and what you're doing out there.

[Gabriel Hamer] So as an associate professor at Texas A&M, I do a variety of field or lab-based projects studying the ecology and control of multiple vectorborne diseases. And so, not just mosquito-borne viruses like West Nile virus and dengue, but also other systems. One in particular here in Guatemala and in Texas that we study would be *Trypanosoma cruzi*. It's the protozoan parasite that causes Chagas disease in both humans and animals, and it's transmitted by kissing bugs that are actually very large compared to mosquitoes. They're about an inch long. And so we're here also in Guatemala collecting these kissing bugs and looking at dog exposure to *Trypanosoma cruzi* (the agent of Chagas disease).

[Sarah Gregory] So Chagas...actually, I think I'm doing a podcast in the next few weeks about Chagas. But as for the kissing...does that bug bite you? Or...how does that transmit?

[Gabriel Hamer] Triatomines...it's a sub-family of true bugs. They are obligate feeders, that they all through their nymphal instars and as adults, they need to feed on blood. And actually, they're going to be humans or animals or dogs, etc. And then occasionally while they are feeding, they acquire the pathogen from an infected animal and then they... these kissing bugs remain infected. And then that's when as they are feeding on a human or another animal, the parasite is actually...the infectious stage of the parasite is passed through the feces, so actually fecal contamination. And that's one of the routes of human or animal exposure.

[Sarah Gregory] I don't know what I would do if an inch-long big got on me and bit me. It's a very upsetting concept.

Well, now that summer is here, when you're not out in the field, what are your favorite ways to relax?

[Gabriel Hamer] Well, we're here in Guatemala with the family this summer, and we are going to lots of ecological parks. There are great places to tour and sites to see in Guatemala. We still have to go to a volcano, for example. But yeah, our family usually enjoys the outdoors in a variety of ways.

[Sarah Gregory] Well, nice.

Well, thank you for taking the time to talk with me out of your fieldwork and your family time, Dr. Hamer.

[Gabriel Hamer] No problem. Yup, thank you for having me.

[Sarah Gregory] And thanks for joining me out there. You can read the May 2022 article, Domestic Dogs as Sentinels for West Nile Virus, Mexico, online at [cdc.gov/eid](https://www.cdc.gov/eid).

I'm Sarah Gregory for *Emerging Infectious Diseases*.

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